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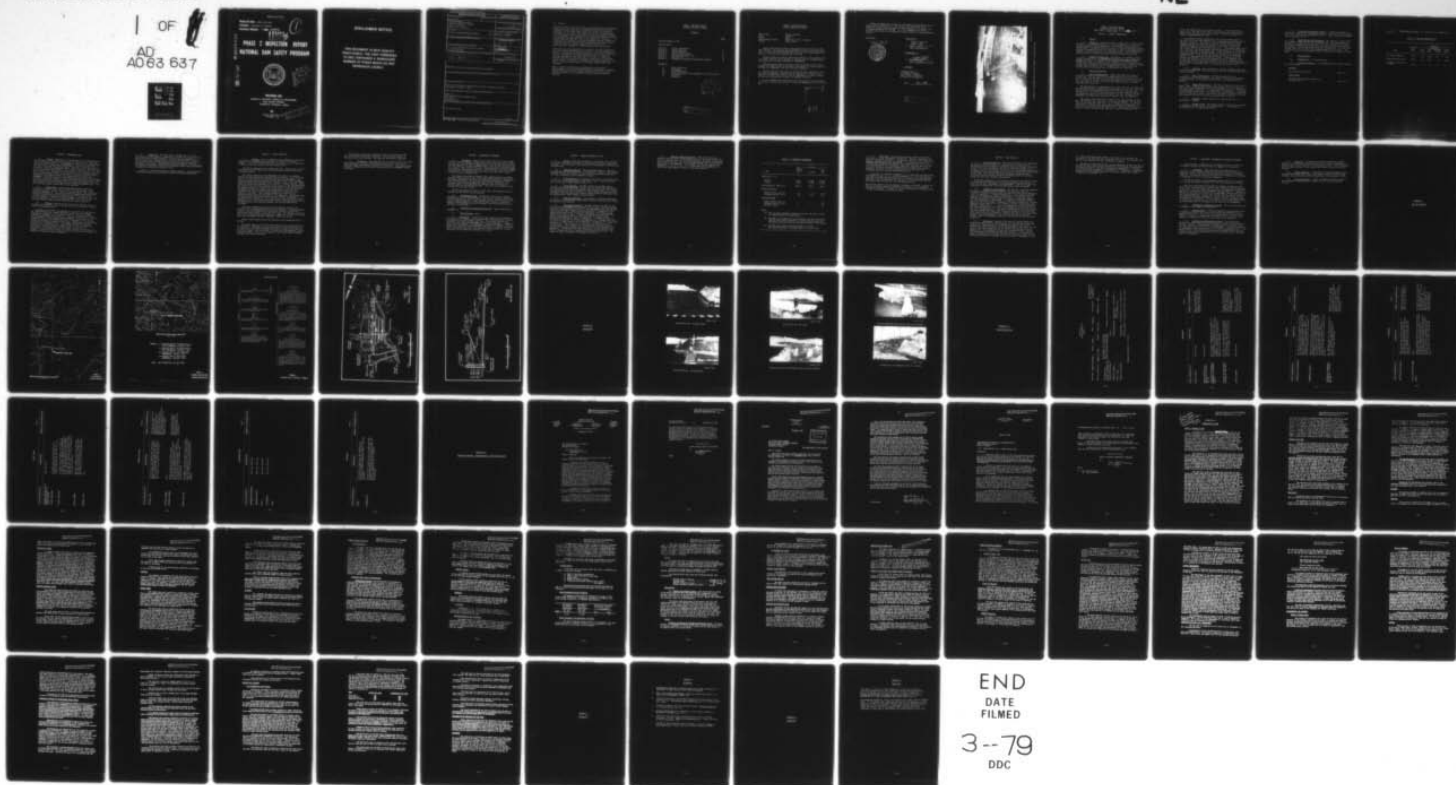
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ROANOKE RIVER BASIN

Name Of Dam: BEAVER CREEK DAM

Location: MARTINSVILLE, VIRGINIA

Inventory Number: VA XXXX 08903

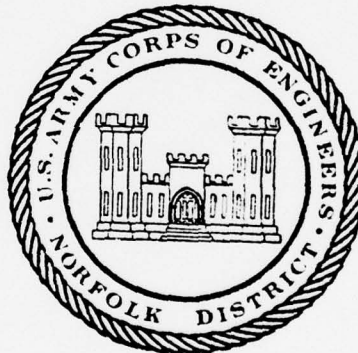
LEVEL II

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

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PREPARED FOR
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY
GILBERT ASSOCIATES, INC.
SEPTEMBER, 1978

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER VA 08903	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Beaver Creek Dam Martinsville, Virginia		5. TYPE OF REPORT & PERIOD COVERED 9 Final rept.
7. AUTHOR(s) Gilbert Associates-Thomas Roberts 10/Thomas E. Roberts		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s) 15 DACW 65-78-D-0014
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineering District, Norfolk 803 Front Street Norfolk, VA 23510		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 12 174p
13. NUMBER OF PAGES 69		12. REPORT DATE 11/ September 1978
14. DISTRIBUTING AGENCY NAME & ADDRESS (If different from Controlling Office) 6 National Dam Safety Program. Beaver Creek Dam (VA 08903), Roanoke River Basin, Martinsville, Virginia. Phase I Inspection Report.		13. NUMBER OF PAGES 69
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dams - VA National Dam Safety Program Phase I Dam Safety Dam Inspection		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) (See reverse side) 154 850		

20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

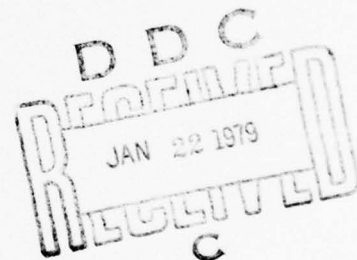
Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Beaver Creek Dam
State: Virginia
County: Henry
USGS Quadrangle Sheet: Martinsville West 7.5 Minute
Stream: Beaver Creek

Beaver Creek Dam (also known as Martinsville Dam) was built in 1955. The structure is an earthfill dam approximately 835 feet long and 68 feet high. It has a concrete lined spillway located at the right abutment and a gate tower located at the upstream toe of the dam.

The dam, which was visually inspected on August 9, 1978, appears to be in a stable condition and to present no imminent hazard, although further investigation of the dam's stability is recommended.

The spillway was found to be able to pass 52 percent of the probable maximum flood (PMF) which, as explained in paragraph 5.8, requires that it be rated as "inadequate," but not "seriously inadequate."

The top width and side slopes of the dam have been constructed within the limits of generally accepted practice and the visual inspection and review of available data indicate that the embankment is stable. However, the data were insufficient to permit an adequate evaluation.

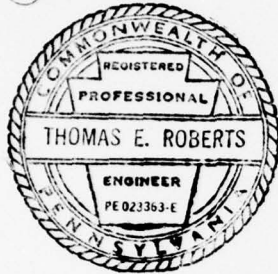
It is recommended that the owner obtain design data from the designer of the dam or initiate new studies to verify the embankment stability of the dam.

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Further recommendations include the development and implementation of a warning system in the event of a dam failure, the institution of an inspection and maintenance program, and the maintenance of a complete file of design information for the dam. It is also suggested that future consideration be given to enlarging the spillway capacity to meet inspection criteria.

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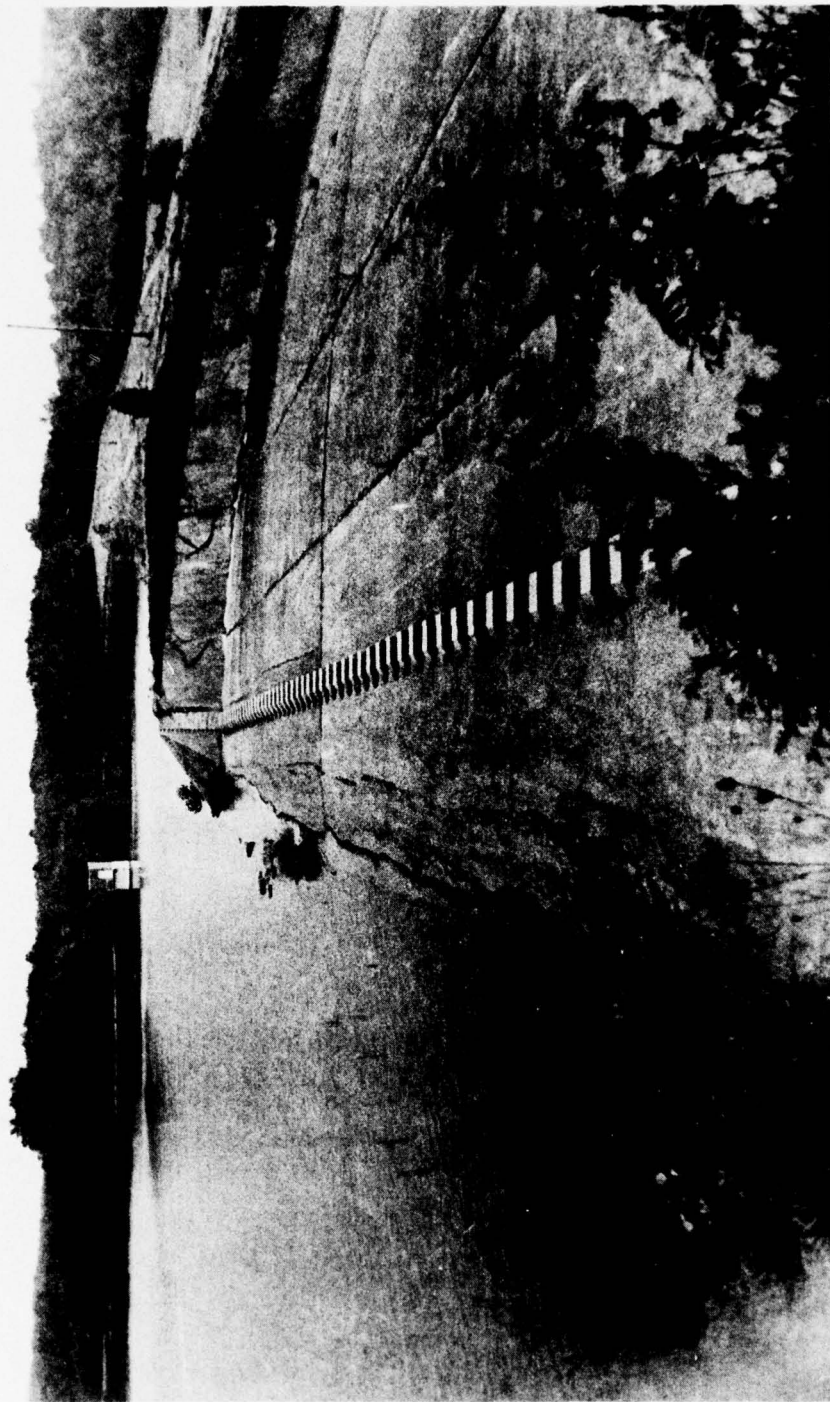
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Major Corps of Engineers
Acting District Engineer

Date: SEP 22 1978

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August 1978

OVERVIEW OF EMBANKMENT AND SPILLWAY ENTRANCE - BEAVER CREEK DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Beaver Creek ID # VA 08903

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into a contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-005.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix V) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description

1.2.1 Dam and Appurtenances: Beaver Creek Dam (also known as Martinsville Dam) is an earthfill dam, approximately 835 feet long and 68 feet high. The dam crest is at a nominal elevation 835 feet m.s.l., and has a top width of 20 feet. Hand-level measurements in the field indicate that the center of the dam is 1.5 feet lower than either end, at about elevation 833.5 feet m.s.l.

The upstream slope is approximately 2-1/2 horizontal to 1 vertical, and the downstream slope is approximately 2 horizontal to 1 vertical, with three 10-foot wide horizontal benches at elevations 820 feet, 800 feet, and 780 feet m.s.l. A 17-foot wide gravel road is located along the bottom of the downstream slope for the entire length of the dam. Sketches of the embankment and intake tower are given as Figures 4 and 5 in Appendix I.

The concrete lined spillway is located on the right abutment of the dam. The spillway is a chute type cut through the abutment. The spillway crest at elevation 825.0 feet m.s.l. at its lowest elevation is 170 feet wide and has a lateral slope, giving the side nearest the embankment an elevation 0.5 feet lower than the opposite end. Small concrete blocks are placed at 3-foot intervals across the crest. About 200 feet below the

crest, the channel tapers to a width of 85 feet. A flip bucket forms a small pool at the base of the chute, from which the chute continues at a gentle slope and terminates at Beaver Creek. The total spillway chute length is approximately 510 feet.

A reinforced concrete intake tower with a brick superstructure is located at the toe of the upstream face, or approximately 200 feet east of the crest of the dam. The tower is a hollow concrete structure which regulates the flow of water from the dam by a series of gated 24-inch diameter openings, at invert elevations of 770.25 feet, 781.50 feet, 790.00 feet, 805.00 feet, and 816.00 feet m.s.l. A horizontal tunnel leaves the intake tower and passes beneath the dam and emerges on the downstream toe on the west side of the gravel road. Inside the tunnel, a 24-inch cast iron pipe (supported on concrete saddles) carries water to the nearby pumping station. At the end of the concrete tunnel, the 24-inch pipe is joined to a right angle tee and reducer fitting. From this point the 24-inch line branches to the right continuing on to the pumphouse and a 14-inch gate valve at the end of the reducer fitting is connected to an 18-inch concrete drain pipe about 450 feet long, which carries discharges to Beaver Creek. The 18-inch drain is the only gravity outlet of the reservoir.

1.2.2 Location: Beaver Creek Dam is located on Beaver Creek east of Virginia Highway 108, four miles north of the city of Martinsville, Henry County, Virginia.

1.2.3 Size Classification: The dam is classified as an intermediate size structure based on its height (68 feet) and impoundment (5,680 acre-feet), in accordance with Section 2.1.1 of Reference 1 of Appendix V.

1.2.4 Hazard Classification: The dam is located in a rural area on Beaver Creek. A medium duty Virginia state highway (VA 714) and several homes are located approximately 1/2 mile downstream of the dam. Based upon the requirements of Section 2.1.2 of Reference 1 of Appendix V, the dam has a high hazard classification. The hazard classification used to categorized dams is a function of location with respect to people and property only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: Beaver Creek Dam is owned by the city of Martinsville, Virginia.

1.2.6 Purpose of Dam: The primary purpose of the dam is to provide an impoundment for the city's water supply system. It also serves as a recreational area for fishing and boating.

1.2.7 Design and Construction History: The dam was designed in 1948 by Wiley and Wilson of Lynchburg, Virginia. Construction was not begun until 1954. The dam was constructed by the J. M. Bless Construction Company and was completed in 1955.

1.2.8 Normal Operational Procedures: The reservoir is used as the water supply storage for the city of Martinsville. The normal operating procedure is to maintain the reservoir at the level of the spillway crest. All inflows exceeding the storage capacity of the reservoir are passed over the spillway. The average water use at the treatment plant is 4.3 million gallons a day (m.g.d.) and it has a maximum capacity of 6.0 m.g.d. The reservoir has never been drained and the 18-inch reservoir outlet is rarely used.

1.3 Pertinent Data

1.3.1 Drainage Area: 9.71 square miles.

1.3.2 Discharge at Dam Site: The maximum historic flood at the dam site is not known.

Spillway:

Pool level at top of dam 9,640 c.f.s.

Outlet Works:

18-inch drain pipe with reservoir at
spillway crest 39.6 c.f.s.

1.3.3
Table 1.1.

Dam And Reservoir Data: Pertinent data are summarized in

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet m.s.l.	Area acres	Reservoir Capacity		Length miles
			Acre feet	Watershed inches	
Top of Dam (Nominal)	833.5	212	5,680	11.0	1.85
Ungated Spillway Crest	825.0	175	4,040	7.8	1.84
Streambed at Centerline of Dam	765±	0	0	0	0

SECTION 2 - ENGINEERING DATA

2.1 Design: Some plans for the dam and a set of specifications were provided for the inspection by the city of Martinsville. The plans give a preliminary layout of the embankment and details of the intake tower and the concrete conduit under the embankment. There are no dam cross sections or profiles currently available. According to the specifications, the dam is a zoned fill embankment with a central clay core. The clay core was to have been extended down in a core trench to solid material, e.g. hard pan or stable rock. The dam was also provided with five drainage systems. Three of the drainage systems as described in the specifications appear to be underdrains designed to reduce the seepage pressures within the embankment. The exact location of the drains were not shown on the drawings provided. The fourth system is a surface drainage system consisting of drop inlet catch basins and a pipeline which were installed along the dam crest and along each of the three benches on the downstream embankment slope. The fifth drainage system is under the concrete spillway.

2.2 Construction: Some construction information has been provided by the owner in the form of letters from the designer, from a consulting geologist, and to a concrete grouting company. The letters are included in Appendix IV. The letters from the designer and the geologist concern the availability of borrow materials and the suitability of alternate supplies. Reference is made throughout to the conditions at the site and the quality of the work being performed. The letter to the grouting company authorizes them to proceed with work on the dam.

2.3 Operation: No records are kept of the reservoir levels or releases below the dam. However, records are kept of the amount of water used at the treatment plant.

According to the owner's representative, soon after the construction was completed some minor seepage developed through the left abutment. Although the seepage was not considered serious, a foundation grouting program was undertaken to eliminate it. The work was carried out in 1955 by the Cunningham Core Drilling and Grouting Company. Some details of the program are given in the authorizing letter in Appendix IV, but the exact details of the grouting program are not known. Reportedly, the grouting was ineffective at reducing the flow. The seepage situation was finally resolved by the construction of a gravel drain to carry the water away. According to the Superintendent of Public Works for the city of Martinsville, the seepage was never considered a threat to the dam and the attempt to eliminate it was carried out to satisfy adjacent land owners. No seepage was observed during the inspection.

2.4 Evaluation: The lack of basic design data, i.e. cross sections and profiles, makes it impossible to evaluate the stability of the dam on the basis of design features. The specifications (Appendix IV) indicate that certain design features, such as zoned earthfill, impervious core, cutoff trench, and underdrain and surface drainage systems, were considered in the design. The seepage through the abutment, although it is now apparently adequately handled by the drainage system, should be measured if possible, to detect any increase in flow.

Initially, it should be checked at monthly intervals. Once the pattern of seasonal variation is established it should be checked semiannually.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: From all appearances the embankment spillway and outlet works are performing well and show no evidence of structural weakness. At the time of the inspection, the reservoir was full and about 2 inches of water was flowing over the spillway crest.

The spillway appeared to be in good condition. There were no cracks in the concrete and the construction joints had recently been sealed with a bituminous material.

The visual inspection of the embankment was difficult to evaluate because tall grass obscured significant surface features. Scattered trees from 3 to 6 feet high are also interspersed along the embankment. The riprap along the waterline appeared to have been filled in with embankment materials washed down from above, but it showed no sign of erosion. Heavy brush also covered the upstream face of the dam. A surface drainage system was found on the crest of the dam and on the benches of the downstream face. The system consisted of concrete inlet boxes spaced at 150-foot intervals. Presumably the boxes are connected by piping which carries the flow downstream, but heavy concrete covers prevented the inspection of the interior of the inlet. This drainage system was not shown on the preliminary plans which were provided for the inspection. Reference to the drainage system is made in the specifications provided in Appendix IV. It was observed that the dam was 1 to 2 feet lower at the center than at the abutments, but it could not be determined from the drawings whether this was a design feature of the drainage system or due to post-construction settlement.

The owner's representative reported that when the reservoir was initially filled seepage appeared at the left abutment. A grouting program failed to stop the seepage and the problem was eventually resolved by installing a gravel drain to carry the water away. The seepage still exists but was not visible during the inspection. Reportedly, the rate of flow was small and the seepage was never considered a threat to the dam.

Several large animal burrows were observed on the downstream face of the dam.

The intake tower was located in the reservoir and was inaccessible for the inspection. Reportedly, all gates work well but because the flow rate is controlled at the water treatment plant below the dam, their positions are rarely changed. The outlet pipe is routed under the embankment through a concrete tunnel. The end of the tunnel was dry, indicating no seepage problems exist within the tunnel.

The reservoir slopes near the dam were gentle to moderately steep. Most of the slopes were heavily vegetated. The downstream channel is relatively flat with low banks. The banks are also heavily vegetated.

3.2 Evaluation: The inspection did not find any conditions which appear hazardous. The grass and brush had been allowed to grow to an excessive height which severely hindered the inspection. The animal burrows should be eliminated, and the small trees growing on the embankment should be removed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Water for use in the Martinsville water supply is drawn from the reservoir through the 24-inch outlet pipe under the dam. The water is routed through a pumping station near the base of the spillway and then pumped to the water treatment plant. The average system water use is 4.3 m.g.d. with a peak of 6.0 m.g.d. During periods of low water demand the system can operate by gravity flow. The inlet tower controls the depth at which water is withdrawn from the reservoir, but the rate of flow is controlled at the treatment plant.

The reservoir provides an adequate water supply capacity for normal seasonal conditions and to date it has never been drawn down significantly by drought conditions. The city has considered increasing the reservoir size to provide capacity for meeting severe drought conditions. The increased capacity would probably be achieved by the installation of spillway gates on the existing spillway. This plan is not expected to be carried out in the near future.

The 18-inch reservoir outlet is rarely used. The reservoir level is controlled by the flows over the spillway.

4.2 Maintenance of Dam: Maintenance of the dam is normally performed by the city of Martinsville. The city has recently repaired the concrete construction joints in the ungated spillway by filling the joints with a bituminous material. Normal maintenance consists of occasional mowing of the embankment grass and cleaning of the stilling basin pool at the base of the spillway.

4.3 Maintenance of Operating Facilities: Same as described in paragraph 4.2

4.4 Warning System: None

4.5 Evaluation: At the time of the inspection, the vegetation had been allowed to grow to an excessive height, indicating that it should be attended to at more frequent intervals. A few animal burrows were observed on the downstream embankment which should be plugged. A number of small trees are growing on the embankment and should be removed. With the exception of the above, the maintenance appeared to be adequate to keep the dam in serviceable condition. The lack of a warning system is a serious deficiency and one should be developed for the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC DATA

5.1 Design: There are no hydraulic or hydrologic data available on the dam except for the drawings of the hydraulic structures supplied by the owner. Our evaluation of the capacities of the hydraulic structures are included below.

5.2 Hydrologic Records: The stream gage nearest to the site is the USGS gage #02073000 Smith River at Martinsville, Virginia. The average discharge at the gage has been 1.2 cubic feet per second per square mile (c.f.s.m.), based on a record length of 49 years.

5.3 Flood Experience: According to the owner, the greatest depth of flow over the spillway crest has been about 2 feet. This level would give a flow rate of approximately 2,700 c.f.s.

5.4 Flood Potential: The PMF, one-half of the PMF, and the 100-year floods were determined for this site by a method developed by the Soil Conservation Service using regional precipitation values. The results of these studies are given in Table 5.1. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: The reservoir is normally maintained at the level of the spillway crest except for periods when water use exceeds the inflow to the reservoir.

5.6 Overtopping Potential: The PMF, one-half the PMF, and the 100-year flood hydrographs were developed for the Beaver Creek Dam drainage basin and routed through the reservoir. The hydrographs were developed and routed using the HEC-1 computer program (Reference 2 of Appendix V) and appropriate precipitation, losses, unit hydrograph, and storage volume versus outflow data as input. Probable maximum precipitation (PMP) and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 3 and 4 of Appendix V). A reduction factor of 20 percent was applied to the PMP as recommended for a drainage basin with an area of 10 square miles or less (Reference 5 of Appendix V). Losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.30 inch/hour. The triangular unit hydrograph was developed from the drainage area and an estimated time to peak of four hours (Reference 5 of Appendix V). Information from field measurements and observations from record drawings were used to compute the storage-outflow relation. The results of these calculations are presented in Table 5.1.

5.7 Reservoir Emptying Potential: The time to drain the reservoir from the level of the spillway crest to the level of the lowest outlet in the gate tower was calculated assuming a discharge through only the 18-inch drain pipe. No flow was assumed through the 24-inch pipeline which leads to the pumphouse. An upstream inflow to the reservoir was assumed at 1 c.f.s.m. or 9.71 c.f.s. Based upon these assumptions, it should take approximately 94 days to drain the reservoir.

Table 5.1 - RESERVOIR PERFORMANCE

Item	Flood		
	One Percent (a)	1/2 PMF	PMF (b)
Peak Flow, c.f.s.			
Inflow	4,210	10,800	21,600
Outflow	2,930	9,030	20,700
Peak Elevation, feet m.s.l.	829.0	833.1	836.0
Ungated Spillway			
Depth of Flow, feet (c)	2.1	4.4	6.0
Average Velocity, f.p.s.	8.2	12.1	13.8
Dam Overtopping			
Depth of Flow, feet (c)	-	-	1.1
Average Velocity, f.p.s.	-	-	6.0
Duration, hours	-	-	6

Notes:

- (a) The 1 percent exceedance frequency flood has one chance in 100 of being exceeded in any given year.
- (b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.
- (c) The dam crest varies in elevation from 1 to 2 feet.
This depth represents the average depth at critical flow.

5.8 Evaluation: Three spillway capacity ratings are possible under the U.S. Corps of Engineers' guidelines: Adequate; Inadequate; and Seriously Inadequate (Reference 1 of Appendix V and U.S. Corps of Engineers' Engineer Technical Letter No. 1110-2-234). The screening criteria for assessing the adequacy of the spillway allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate that most non-Federal dams will have an inadequate spillway.

A spillway is considered "inadequate" if it cannot pass the PMF without overtopping the dam. It is "seriously inadequate" if it is overtopped by less than a one-half PMF that could lead to a failure of the dam, possibly resulting in an increased hazard of the loss of life downstream from that which would exist just prior to the overtopping failure.

The spillway capacity was calculated at 52 percent of the PMF. Because the capacity exceeds 50 percent of the PMF, the spillway is not considered "seriously inadequate." The PMF will overtop the dam at its lowest point by 1.7 feet for a duration of about six hours.

SECTION 6 - DAM STABILITY

6.1 Stability Analysis: Data on the stability of the embankment are not available for review. It is possible that the designer has performed the stability analysis during the design of this dam, but because of the lack of this information, the lack of structural design cross-sections, and the lack of design and in-situ soil and foundation parameters, an adequate and valid evaluation of the stability of this dam cannot be made at this time. The need for additional subsurface information and a structural stability analysis should be determined after all pertinent design data have been obtained and evaluated.

The visual evidence of 1 to 2 feet of variation in the crest elevation of the dam may have been part of the surface drainage system design. It could also be due to settlement of the embankment. The latter might be an indication of instability, for which additional studies are needed.

6.2 Foundation and Abutments: The dam lies in the area underlain by coarse to porphyritic biotite granite with relatively deep soil overburden of reddish saprolite and silty sand with fine gravels (Reference 6 and 7 of Appendix V). Intense decomposition of the scattered outcrops along the left downstream roadcut was observed. In accordance with a construction inspection report made by Dr. Byron N. Cooper (See Appendix IV), the preparation of the bedrock - a weathered and somewhat friable granite in the cutoff trench - appeared to be wholly satisfactory. Another inspection report made by Mr. W. M. Johnson of Wiley & Wilson Consulting Engineers, stated that "... and to all appearances a satisfactory bond was obtained between the solid rock of the foundation and the clay fill of the core" (See Appendix IV). The owner's representative stated that there was minor seepage occurring in the downstream abutment area to which the south wing of the dam is connected. Attempts were made to stop the seepage by grout injection (Appendix IV) but good results were not achieved. However, none of the seepage in that area was observed during this visual inspection.

6.3 Evaluation: Because of the lack of important design and construction data, such as cross-sections, profiles, and elevations, and insufficient foundation and soils information, complete and accurate evaluation of the dam stability can not be performed at this time. On the basis of the visual inspection and two construction inspection reports (Appendix IV), the dam appears to have been constructed with a concern toward foundation conditions and materials placement. The dam shows no signs of instability; except that the vertical variation in crest surface and the past history of a seepage area as set forth in paragraphs 6.1 and

6.2 create some concern with respect to the stability of the dam. An evaluation of the dam stability, including review of all the pertinent data which are not available for this inspection, is needed.

The dam is located within Zone 2 on the Algermissen Seismic Risk Map of the United States (1969 Edition) and there are uncertainties with respect to the static stability of the dam as described in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix V, assessments should be considered regarding seismic stability, based on the studies recommended in paragraph 7.2.3.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations, and remedial measures contained in this Report are based on the provisions of Appendix VI, Conditions.

7.1 Assessment: Based upon the visual inspection and an evaluation of the available design and construction documentation, this inspection found no indication that the dam was presently in a hazardous condition. The spillway capacity was found to be "inadequate" as described in paragraph 5.8, but not "seriously inadequate."

The PMF flood which is the recommended design flood for the spillway will overtop the dam by a maximum of 1.7 feet for a duration of 6 hours.

The lack of sufficient data prevented a complete evaluation of the stability of the dam; however, from the visual inspection the dam appeared to be stable. The side slopes and top width of the embankment conform with generally accepted practice for embankment dams (Reference 5 of Appendix V). The lack of any signs of distress in the embankment indicates that the dam has been performing well to date, and favorable reports from the designer and consulting geologist (Appendix IV) indicate that the stability was a consideration in the design. However, despite the dam's appearance, there is insufficient information as to its stability, and further research of the existing design files or re-analysis of the stability is recommended.

7.2 Recommendations/Remedial Measures: The following actions are recommended for the owner's consideration.

7.2.1 Warning System: A detailed emergency warning system should be developed within 60 days to notify the downstream inhabitants of an impending dam failure. In order for the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

7.2.2 Inspection and Maintenance Program: The owner should establish an annual inspection program which would observe the condition at the dam, especially noting seepage, sloughing, erosion, shrinkage cracks, and other indications of distress in the embankment. The grass and brush on the embankment should be mowed and cut on a routine maintenance basis. The animal burrows on the downstream face should be examined further and then plugged properly with suitable material, and trees should not be allowed to grow on the embankment.

7.2.3 Stability: The owner should obtain information from the designer or initiate a new study which would verify that the embankment is stable and has suitable factors of safety against failure. This information should be made available to the Virginia State Water Control Board within 120 days.

7.2.4 Design Documents: A complete set of design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence, and maintenance records.

7.2.5 Spillway Capacity: Future consideration should be given to the enlargement of the spillway to comply with the Corps of Engineers' criteria.

APPENDIX I
MAPS AND DRAWINGS

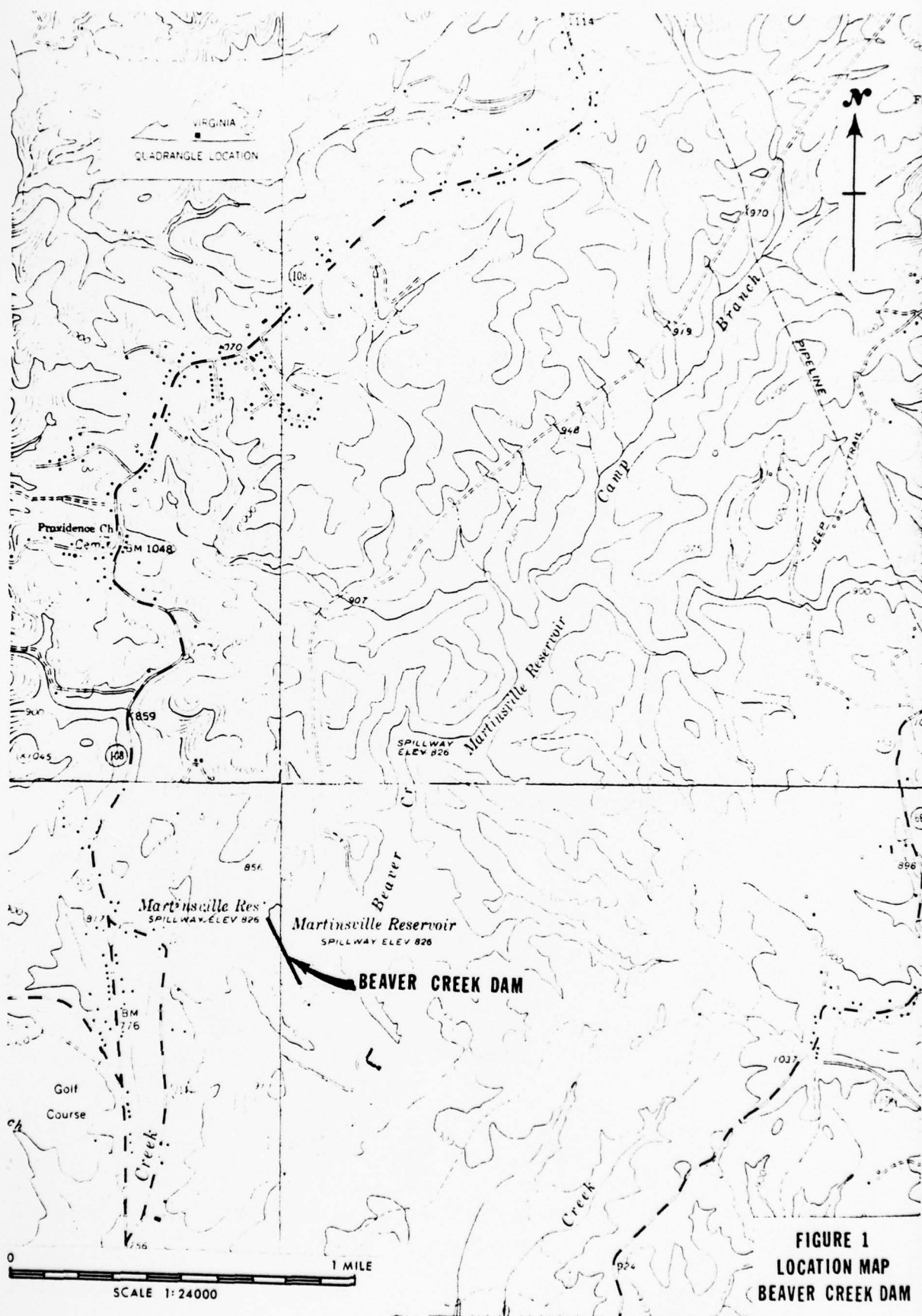
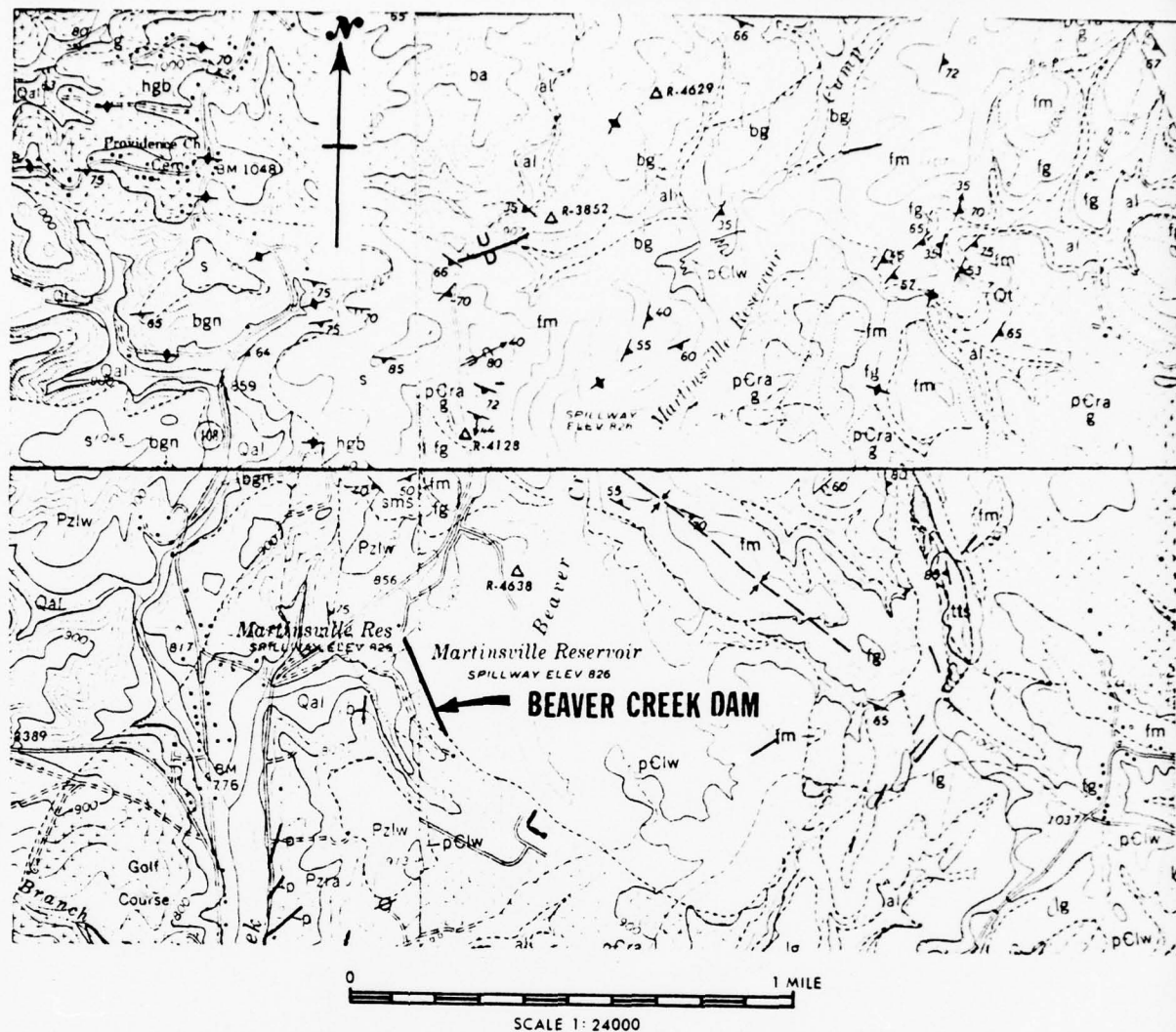


FIGURE 1
LOCATION MAP
BEAVER CREEK DAM



- SOURCES: (1) GEOLOGIC MAP OF THE MARTINSVILLE EAST QUADRANGLE, VIRGINIA, 1972
 (2) GEOLOGIC MAP OF THE MARTINSVILLE WEST QUADRANGLE, VIRGINIA, 1968
 (3) GEOLOGIC MAP OF THE SNOW CREEK QUADRANGLE, VIRGINIA, 1972
 (4) GEOLOGIC MAP OF THE BASSETT QUADRANGLE, VIRGINIA, 1970

NOTE: FOR EXPLANATION, SEE NEXT PAGE

FIGURE 2
 REGIONAL GEOLOGIC MAP
 SHOWING DAM LOCATION

EXPLANATION

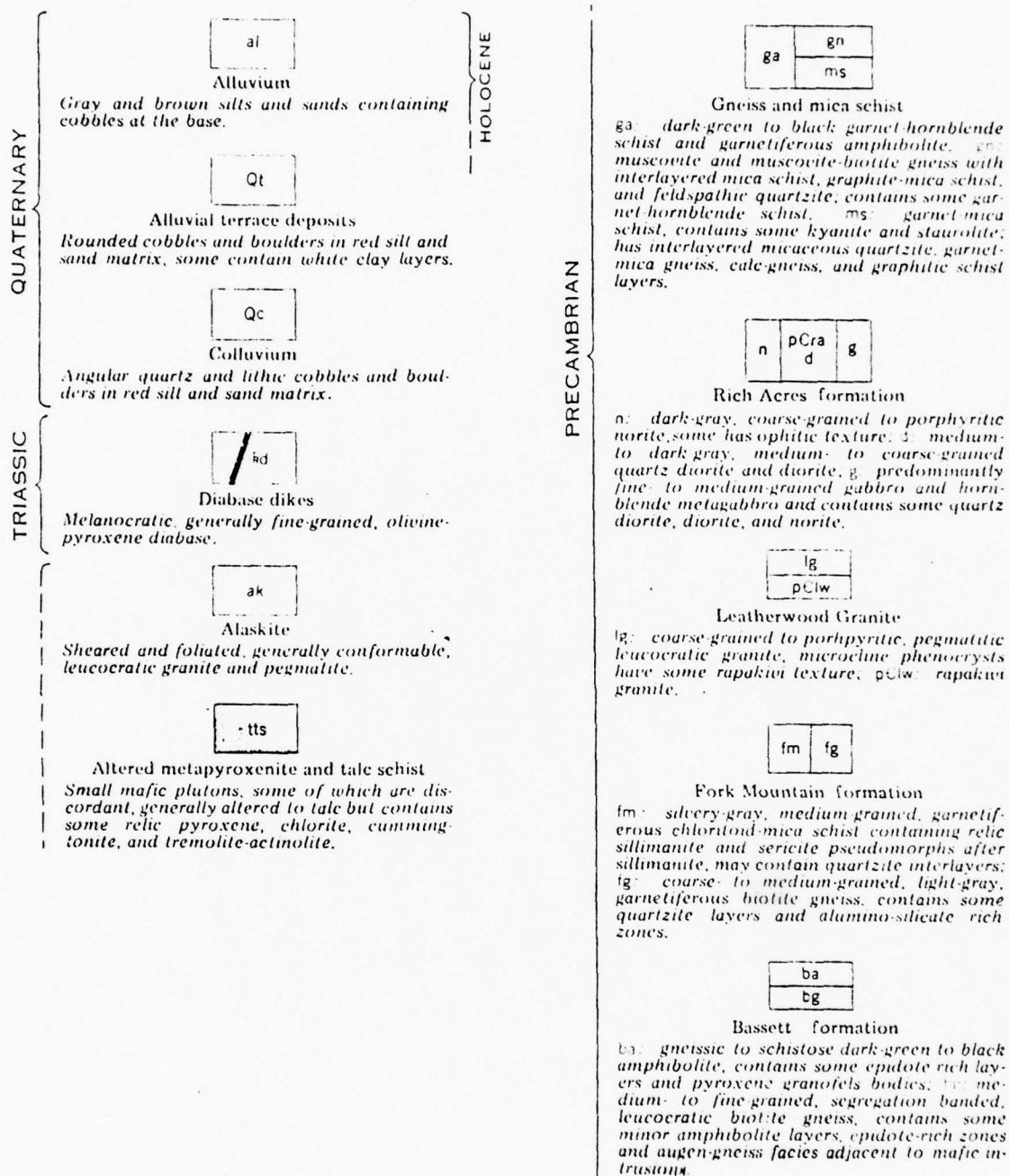


FIGURE 3
EXPLANATION OF GEOLOGIC SYMBOLS

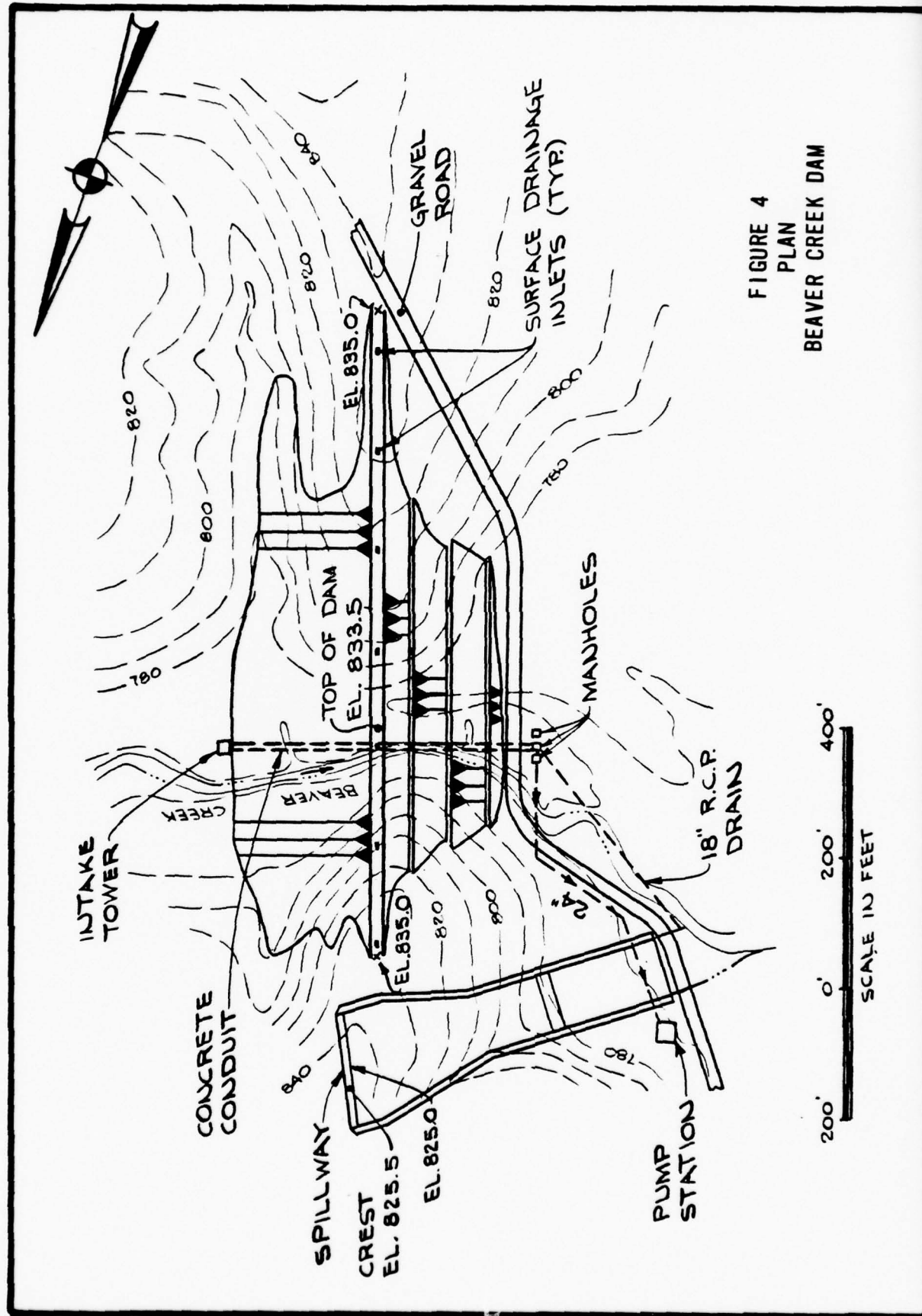


FIGURE 4
 PLAN
 BEAVER CREEK DAM

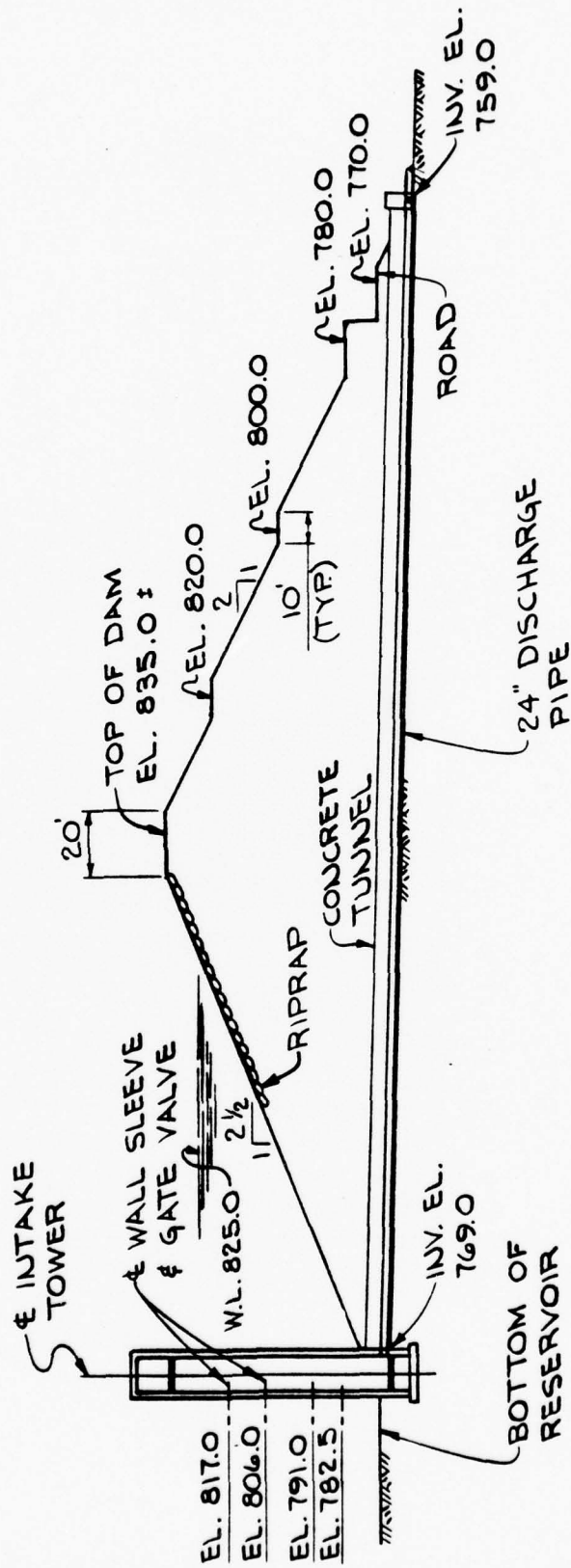
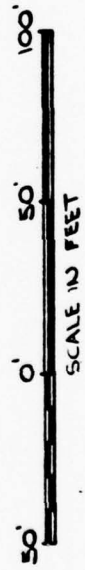
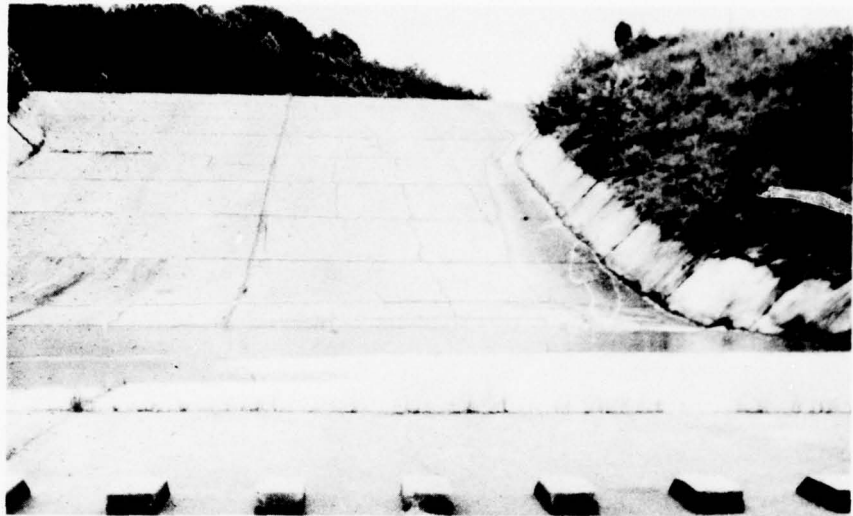


FIGURE 5
SECTION
BEAVER CREEK DAM



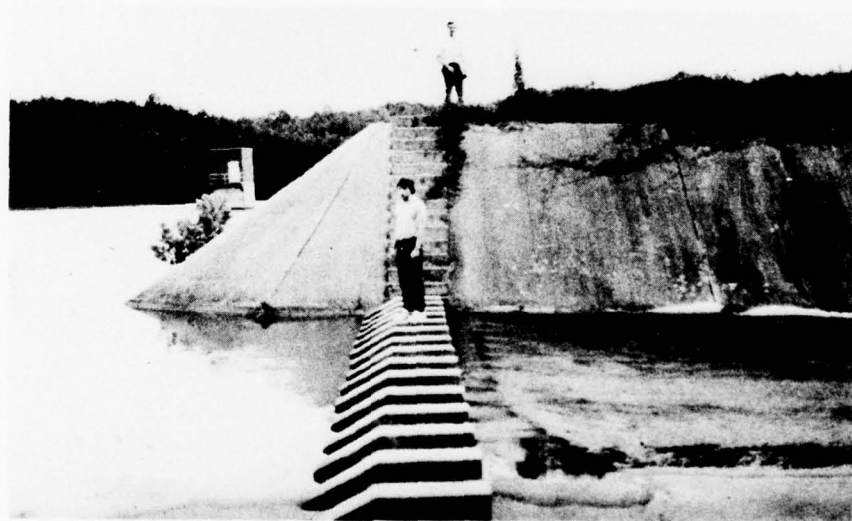
APPENDIX II

PHOTOGRAPHS



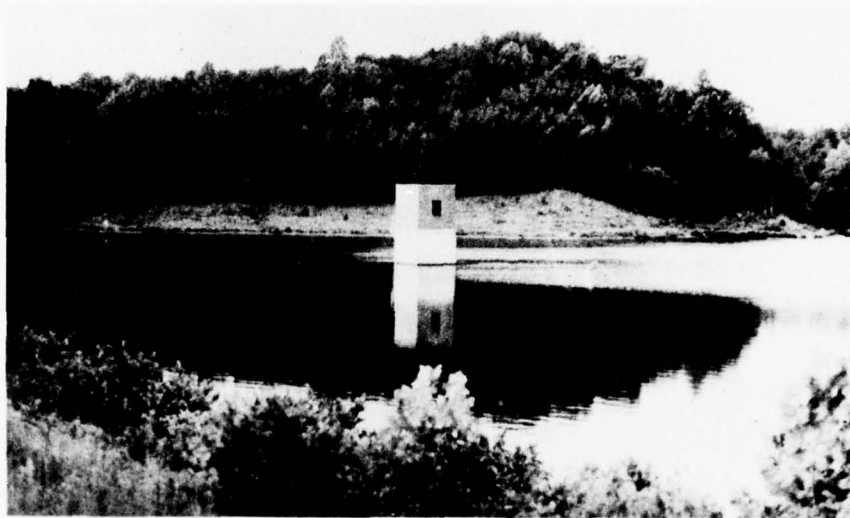
August 1978

BEAVER CREEK DAM - SPILLWAY CHUTE



August 1978

BEAVER CREEK DAM - SPILLWAY CREST



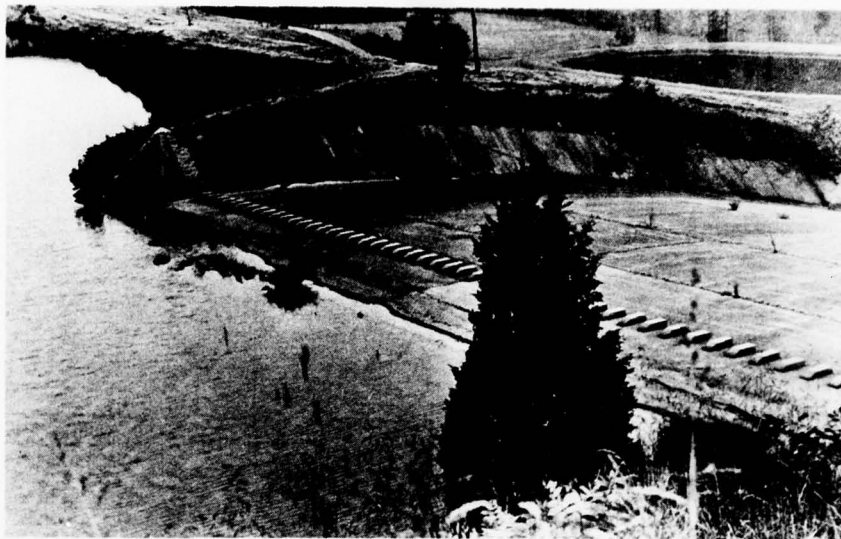
August 1978

BEAVER CREEK DAM GATE TOWER



August 1978

UPSTREAM SLOPE OF THE EMBANKMENT FROM THE RIGHT ABUTMENT



August 1978

VIEW OF EMBANKMENT AND SPILLWAY FROM RIGHT ABUTMENT



August 1978

UPSTREAM FACE OF EMBANKMENT FROM LEFT ABUTMENT

APPENDIX III
FIELD OBSERVATIONS

Check List
Visual Inspection
Phase 1

Name Dam: Beaver Creek Dam County: Henry State: Virginia Coordinators: Norfolk District,
U.S. Army Corps of Engineers

Data(s) Inspection: August 9, 1978 Weather: Clear, Hot Temperature: 92°F

Pool Elevation At spillway crest elevation
at Time of Inspection: 826.0 feet m.s.l., based upon
USGS 7-1/2 minute quadrangle
Gilbert Associates, Inc.
Inspection Personnel:

Tailwater at Time of Inspection: Unknown

Others:

Thomas E. Roberts

Donald Richardson - Superintendent, Department of
Public Works,
city of Martinsville

Fine T. Hsu

Thomas W. Schreffler

Phillip Henry - City Engineer, city of Martinsville

David E. Lucado - Virginia State Water Control Board

Thomas W. Schreffler - Recorder

EMBANKMENT

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	Dense and long grass and brushes cover the entire embankment and have limited the extent of observation.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Active surface sloughing was not observed at the embankment, although minor surface irregularities may attribute to the previous sloughing. Some small erosion gullies were observed in the downstream roadcut area, primarily at left abutment.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The crest of the dam showed some vertical variations on the order of approximately 2 feet; generally, the south section of the crest is higher than the central part.	The variation in vertical alignment could be due to either the planned surface drainage system or post-construction settlement of the embankment.
RIPRAP FAILURES	None observed.	Riprap is extended to about 2 feet above the water level along the upstream slope at the time of inspection.

EMBANKMENT

Sheet 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FOUNDATION AND ABUTMENTS	<p>The dam lies in the area underlain by coarse to porphyritic biotite granite with relatively deep soil overburden of reddish saprolite and silty sand with fine gravels. Intense decomposition of the scattered bedrock along the left downstream roadcut was observed.</p>	
EMBANKMENT MATERIAL	<p>Exposed surficial material along the downstream slope indicated that the shell of the dam may be composed of red to brownish red fine sandy silt, clayey silt with some fine gravels. One of the borrow areas, located half a mile west of the dam and shown by the owner's representative, was examined. The material is chiefly red residual silty clay with some fine gravels.</p>	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	<p>The embankment appears to key satisfactorily into the abutments. The junction of the spillway and the embankment showed no signs of seepage and erosion.</p>	<p>Seepage at the left abutment occurred soon after the dam was constructed. Some remedial measures were taken which routed the seepage into the underdrain system. No seepage was observed.</p>

EMBANKMENT

Sheet 3

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	None observed (an owner's representative reported that minor seepage occurred previously at the downstream left abutment near the embankment toe area, but this seepage condition was not observed at this time.)	Grouting was conducted in order to stop the leakage in 1955, but was not effective.
STAFF GAGE AND RECORDER	None.	
DRAINS	Surface drainage ditches were seen along each downstream bench, and a steel drain pipe about 14 inches in diameter underlying the downstream road was observed near the contact of the downstream toe and the left abutment. Moreover, concrete catchbasins with cover slabs (4 feet by 4 feet) were observed at a spacing of 150 feet along the dam crest.	No layout and section drawings of underdrain and surface drainage systems are available for evaluation. The specifications indicate an underdrain system was constructed under the downstream embankment.

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed.	
INTAKE STRUCTURE	An intake tower in the reservoir was visible from the dam, but was not inspected because of the lack of access.	
OUTLET STRUCTURE	A 24-inch cast iron pipe is installed in a concrete conduit through the embankment. At the end of the conduit the pipe branches to the right and continues to the pumping plant. At the branch an 18-inch drain line controlled by a 14-inch valve leads to Beaver Creek 450 feet away. A concrete headwall is at the end of the line.	
OUTLET CHANNEL	The outlet channel lies in the alluvial deposits, mainly gravels, of Beaver Creek. The creek is heavily vegetated but more than adequate to carry the discharge flows.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	The surface of the concrete weir and walls shows no sign of deterioration and cracking. There is some dumped riprap at the upper end of the weir. The upper part of concrete wall slope is about 40° to the horizontal.	The owner's representative reported that some underseepage was observed apparently coming from beneath the spillway chute. After having repaired the joint with sealing substance, all seepage was stopped.
APPROACH CHANNEL	None.	
DISCHARGE CHANNEL	Except for minor fine surface cracks occasionally observed, the concrete-paved section of the discharge channel is in good condition with the lower section cut in the natural alluvial deposits. Reportedly, the paving joints in the channel were recently tarred.	Some red-orange chemical precipitation (probably Fe_2O_3) on the concrete and unpaved channel floor was observed.
BRIDGE AND PIERS	No bridges or piers but small concrete blocks are spaced across the crest at 3-foot intervals. These are apparently to be used as stepping stones for crossing the spillway while it is flowing.	

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None were observed.	
OBSERVATION WELLS	None were observed.	
WEIRS	None were observed.	
PIEZOMETERS	None were observed.	
OTHER		

RESERVOIR

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes near the dam appear to be gentle to moderately steep. Most of the area near the dam is moderately dense to densely vegetated.	
SEDIMENTATION	Erosion in the reservoir area is minimal because of the dense vegetation cover near the dam. The headwater region and inflow drainage condition were not examined because of difficult accessibility.	

APPENDIX IV

INSPECTION REPORTS, CORRESPONDENCE, AND SPECIFICATIONS

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E. J. F. WILSON
E. B. BOYNTON
W. M. JOHNSON
W. E. ROYALL
V. L. WOOD

WILEY & WILSON
CONSULTING ENGINEERS

LYNCHBURG, VA.
608 PEOPLES BANK BUILDING
TELEPHONE 3-1363

RICHMOND, VA.
711 WEST MAIN STREET
TELEPHONE 3-3317

ASSOCIATES
E. J. F. WILSON, JR.
G. M. PERRY
R. B. MANNITT, JR.
T. R. LEACHMAN
GEO. HUNT

REPLY TO LYNCHBURG OFFICE

September 30, 1953

Mr. Kent Mathewson, City Manager
City of Martinsville
Martinsville, Virginia

Re: Water Works Dam
Martinsville, Virginia

Dear Mr. Mathewson:

This is in reference to your letter of September 11th
and your letter of September 29th.

It appears, after careful investigation of the foundation of the dam, that solid ledge rock was encountered under the tunnel for a distance of 100 ft. upstream and downstream along the tunnel through the dam. This material has a granite-like structure and was solid and firm along the entire distance. A material of similar nature extended under the keyway, north along the keyway in the bottom at the lowest point of the foundation for the Class "A" core material, and to all appearances a satisfactory bond was obtained between the solid rock of the foundation and the clay fill of the core. We believe that any possibility of the foundation being a boulder was eliminated when the entire area was cleared off to approximately a level surface with power machinery consisting of a backhoe and bulldozer. The material was removed as long as it could be cut with the power equipment; and when no further material could be removed, the remaining rock structure was used as a foundation.

We expect to have Dr. Syron N. Cooper, Geologist at V.P.I., check further into the material available for the Class "A" and "B" sections of the embankment.

The Class "B" material available can be satisfactorily compacted with equipment available and with proper moistening of the fill as it is placed. The clay core of Class "A" material is reaching a level above the foundation where its importance is diminishing, and we believe that there will be no objection to

Mr. Kent Mathewson
Martinsville, Virginia

- 2 -

September 30, 1953

to completing the upper section of the dam with Class "5" material if Class "A" cannot be readily obtained. Mr. Perrone is paying particular attention to the compaction of all classes of material going into the dam, and this, of course, is an advantage to the contractor in that he is paid for excavation and not material in place. We expect to obtain a shrinkage of approximately 23% with the compaction being obtained; that is, the material is being compacted to 23% more density than in its original location.

Yours very truly,

WILEY & WILSON, CONSULTING ENGINEERS

By


W. M. Johnson

WML:jh

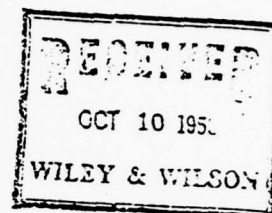
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BYRON N. COOPER
GEOLOGIST
BOX 13
BLACKSBURG, VIRGINIA

V. P. I. OFFICE
8261 EXT. 388

RESIDENCE
100 COUNTRY CLUB DRIVE
TELEPHONE 8738

October 9, 1953



Mr. William Martin Johnson
Wiley and Wilson, Consulting Engineers
905 Peoples Bank Building
Lynchburg, Virginia

Re: Martinsville Water Works Dam

Dear Mr. Johnson:

This letter will confirm certain observations made by me during an inspection of the work on the Martinsville Dam, which I made on Tuesday, October 6th.

The primary purpose of my trip to the dam at Martinsville was to determine the suitability of additional borrow material for use in the corowall and Class B section of the structure.

The original borrow area for "A" material has been exhausted of this grade of material but can by enlargement of the borrow area still yield some Class B material. Class B material can be obtained in considerable quantity from several localities within the reservoir area, from one hill on the northwest side of the creek and from two additional hills on the opposite side of the creek.

All of these places yield some good impermeable clay in thicknesses of 30 inches to 40 inches. This material, distinguished by its greater weight, plasticity, and higher natural moisture content, is quite suitable for use as Class A material. Generally, this material lies beneath a thin cover of loose, nonplastic silt; and it has to be stripped to be usable as Class A material. The heavier, more plastic material grades downward into a somewhat lighter-weight silty, micaceous residual soil that is compactible under conditions of optimum moisture.

Material of the above types was being placed in the "B" section when the inspection was made, and it was obvious that practically 100 per cent compaction was being obtained. Both "A" and "B" sections of the structure show excellent compaction. It should be mentioned that the materials now being used for "A" and also for "B" material depart in appearance from the heavy plastic clay obtained from the original borrow area, but this difference is nowise detrimental to the structure.

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The "A" and "B" materials now being used contain small granules of blue quartz and whitish particles of feldspar, both of which actually add to the stability and compactibility of the material, rather than detract from these characteristics. The presence of these granules gives each layer of the placed material a firm bit and lock with that previously placed. The somewhat granular texture of these clays belies the fact that there is ample clay fraction to insure water-tightness, but samples of the clays placed on the "A" and "B" sections at about the 785-foot elevation show good density and compactibility.

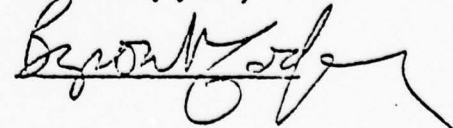
The suitability of the materials for "A" and "B" uses is readily attested by the total lack of soft or spongy spots and the remarkably uniform compaction of the middle and upstream sections, thus far achieved. There was general agreement that the first consideration was to assure ample "A" material from the above mentioned borrow areas, with the remainder of the clay going for "B". From the sampling that was done during the day I visited the dam, I feel certain that ample "A" material is assured, and that the much larger requirements for "B" material can be satisfactorily met by utilizing materials from the original "A" borrow area, an area southeast of the dam and downstream from the centerline of the dam, and from several areas above the centerline of the dam, including three hills on the east side and one hill on the north side of the structure.

The preparation of the bedrock—a weathered and somewhat friable granite—for the keyway and cutoff appeared to be wholly satisfactory. The bedrock conditions at the spillway have not yet been made fully apparent, but it would seem that the weathered granite will have to be completely walled off by concrete from the ravages of the spillway discharge.

The only adverse condition which I noticed on the job and which I pointed out to you centered around the shrinkage cracks in the topmost 4 to 6 inches of fill on the "A" section. At the 785-foot elevation, the "A" section went for a week without receiving material and dried out. The shrinkage cracks in the dried portion formed a series of open fractures that might encourage some leakage through the corewall section. This top layer needs to be kept moist to allay development of shrinkage cracks and to dispose of the cracks already formed. It was understood that the cracked top layer would be roughened and thoroughly wetted to dispose of the shrinkage cracks, prior to placing of more material in the "A" section.

I was very favorably impressed by the way the "A" and "B" materials were working, and I came away feeling that the job was coming along exceptionally well so far as use of proper materials and preparation of the foundation for the earth fill were concerned.

Respectfully yours,



In Triplicate

WILEY & WILSON
CONSULTING ENGINEERS
LYNCHBURG, VA.

COPY

July 9, 1955

Cunningham Core Drilling & Grouting Corp.
1210 Tennessee Avenue
Salem, Virginia

Re: Martinsville, Va. - Water Supply Dam

Gentlemen:

This will advise that we have been authorized to have you begin on drilling and grouting in and adjacent to the west wing of the water supply dam at Martinsville, Va. for the purpose of stopping a leak which appears to be passing through the structure of the hill to which the south wing of the dam is connected.

You are to proceed with this work on the standard rental basis for equipment, materials and labor supplied by you, plus 15% for overhead and profit, as discussed with you yesterday. You are advised that the maximum sum of \$4,000 is available for this work and you will keep us advised as to the cost of the work as it progresses.

It is understood that you will assemble your forces and be ready to start work on July 13th or not later than the 19th, and we will have a representative at Martinsville on the 19th to observe the work. We wish to keep a record of the material encountered and will ask the cooperation of your foreman in keeping us posted as to the material encountered in each hole. We do not wish to keep the core material but merely to determine the character of the material encountered.

It appears that it will be advisable to go to a depth of 10' below the level of the point at which water appears downstream in your drilling and to follow this procedure until the seam conveying the water is located. It appears that the drilling should begin with the upstream face of the dam, drilling through the berms or runway at the top of the dam, but drilling on the upstream face between the rip rap and the top of the fill and farther west along the wing as conditions determine. It appears

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Cunningham Core Drilling & Grouting Corp. -2- July 9, 1955

that an area of approximately 200 ft. may have to be explored with the drill holes first set approximately 20 ft. apart and then split into centers between the test holes until the leakage is encountered.

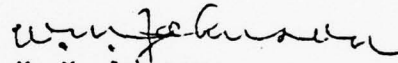
Grouting should not be under greater pressure than 10 or 15 lbs. using cement. We would like to have a record of the amount of cement entering each hole.

We hope you will make record progress in this remedial work and keep us posted as to the progress and cost.

Yours very truly,

WILEY & WILSON, CONSULTING ENGINEERS

By


W. H. Johnson

WMJ-G

cc: Mr. Walker Graves
Mr. Kent Mathewson

Received by
Helf from
Wiley & Wilson
Lyndburg 8/4/28

PROJECT NO. 5

CONSTRUCTION OF DAM

GENERAL OUTLINE OF WORK

The dam is to be located on ~~the site shown~~ as shown on the general location map, and the work will include clearing the site, excavation for and complete construction of a compacted earth fill dam with reinforced concrete intake tower, pipe conduit through the dam, spillway, and discharge canal, as covered by these plans and specifications. The drawings show the location of the foundation as determined by numerous test pits and excavations on the site. The contract will be based on the elevations given and if additional depths or decreased depths are required to secure a satisfactory foundation when excavation is made, proper adjustment will be made in the amount of the excavation, concrete, etc. at unit prices as called for in the Form of Proposal.

The foundation is of disintegrated granite and solid rock of various kinds and it is the intention of these specifications to remove all of the disintegrated stone which can be handled with normal excavating equipment consisting of bulldozers, scrapers, or pans or similar equipment until a thoroughly stable material is encountered, in order that a satisfactory bond may be obtained between the clay core of the dam and the foundation rock to provide a safe and water tight foundation. As a further precaution a drainage system is to be installed as shown to prevent up-lift pressure from the accumulation of water against or in the core of the dam.

The work will include furnishing and installing the gate valves and intake connections and all work necessary for the complete construction of the intake tower, and the pipe conduit through the dam exclusive of the pipe to be located in the conduit from the inside face of the intake tower to the pumping station which pipe and installation is covered by a separate contract. This work also includes the complete construction of the spillway, the concrete paving for the spillway, the spillway canal or flume to convey the water from the spillway to the original channel of the stream below the dam. This work also includes all clearing and grading necessary from a point 300 ft. upstream from the construction base line of the dam, downstream within the limits of the construction, and from end to end of the dam and the spillway and canal within the limits of construction shown on the plans; also all clearing and grading, excavation, transportation of the materials from the borrow pits from which material is to be taken for the dam and the transportation of stone from the city quarry to the dam for use as rip-rap stone or in connection with the underdrain system and ballast sections of the dam; also the furnishing of all drain piping, catch basins and covers, or other drainage structures;

also shaping of drainage ditches shown on the plans, profiles or cross sections, and the finished grading, seeding and planting of the exposed surfaces of the dam, spillway, and canal as called for by these plans and specifications. The complete construction of the dam in accordance with the plans and specifications shall be a lump sum proposal with unit prices on various items to be used as additions or deductions. All unit prices called for in the proposal shall be named by the Contractor. Failure to name such unit prices shall be considered sufficient cause for rejection of the proposal or the owner reserves the right to apply the most favorable unit price for the said item named by other contractors for this item in establishing the unit price where omitted by the contractor in order to obtain a complete proposal.

CLEARING DAM SITE

The area to be cleared at the dam site shall begin at a point 300 ft. upstream from the construction base line of the dam and extend downstream within the limits indicated on the plans and shall include the borrow pit areas necessary for obtaining the material required for the compacted earth fill of the dam, the spillway section and canal, and areas between the canal and the dam in which no excavation is to be required.

Within the area below elevation 835 and a point 300 ft. upstream from the construction base line of the dam all trees, shrubs, and undergrowth of all kinds shall be cut down to the ground and the stumps, grubbed or otherwise completely removed. All trees, shrubs, stumps, or other growth or organic matter, debris, etc., within the limits of the dam shall be removed to a point below the limits of excavation for the dam or spillway and piled at a point within 100 ft. of the canal outside the construction area. Trees, shrubs, underbrush, grass, weeds, etc. not within the limits of construction or the borrow pit areas will not be cleared under this contract. The contractor may use in any manner he desires such trees, shrubs, timber, etc., within the limits of construction or from the borrow pit area or property owned by the City except areas upstream above the 300 ft. line described above. The flooded area and marginal area is covered by the land clearing contract of Project No. 4.

The Contractor may leave trees standing in the vicinity of the dam which will not interfere with construction purposes if necessary for his use as anchors or other purposes but which shall be removed and destroyed after they have served their purpose, and as described above.

EXCAVATION

Excavation shall be as hereinbefore written and in accordance with the special provisions outlined below.

The excavation for the intake tower shall be carried down to solid rock in order that a rigid bond may be obtained between the concrete of the intake tower and the solid rock foundation.

Drill holes shall be made into the solid rock foundation by means of which the reinforcement bars as anchors for the intake tower may be grouted into the solid rock of the foundation.

All areas covered by the Class "B" ballast section of the dam shall be stripped to remove all organic matter from the area to be covered by the ballast section to a minimum depth of 1 ft. below the original surface. Any pockets of organic matter or unstable material or loam which in the opinion of the Engineers must be removed will be ordered removed at the time the stripping operation is in progress or before the ballast section is placed thereon. Areas which are cut or disturbed by construction operations in such manner as to render the material unsound as foundation material shall be removed or stabilized as directed by the Engineers.

The area under the clay core of Class "A" material shall be excavated to a minimum depth of 1 ft. as indicated on the plans for the shallow sections of the dam and a minimum of 2 ft. in the deeper sections of the dam as indicated on the plans. Any pockets of organic matter, debris or unstable material within these areas shall be removed as directed by the Engineers until a stable material is encountered.

~~The cut-off trench for the clay core shall be extended down~~ to a solid material consisting of hard pan, granite or other stable rock or Class "A" clay which in the opinion of the Engineers is satisfactory for the foundation. The excavation will be carried down for the clay core cut-off trench through any material which may be moved by bulldozers, pans, scrapers or similar power driven excavating equipment without the use of explosives. It is not the intention of these specifications to extend the clay core cut-off trench below solid rock or other suitable stable material. Incidental boulders or large stones occurring above solid rock measuring less than 1/2 cu. yd. will be considered as unclassified excavation and shall be removed regardless of size. Those larger than 1/2 cu. yd. shall be paid for as rock excavation.

Excavation for the spillway and spillway canal to the existing creek channel shall be to the lines and grades indicated on the plans including depth to the sub-grade.

BLASTING

Any blasting required in connection with the dam foundation, spillway, or intake tower shall be made with explosives of moderate power and not with high explosives.

DRILLING

Drill holes are required for the foundation of the intake tower to the depth shown on the plans and having a diameter of 2-1/2 in.

These holes shall be drilled with pneumatic drills and the reinforcing steel bars of the intake tower shall be inserted in the holes and grouted into position with cement grout.

UNDERDRAIN SYSTEM

A system of underdrains shall be provided on the downstream edge of the Class "A" core of the dam and in the Class "C" material, consisting of a bed of crushed stone from 2 to 4 in. in size surrounding a drain pipe as indicated on the plans. The lower level underdrain system shall be placed along the finished sub-grade level of the Class "C" ballast section of the dam and laid so that there is a continuous grade for the drain line in the underdrain system to the connecting manhole. The upper level drainage system shall be laid to the grades indicated on the plans and the drain pipe extended out to connect into a manhole as shown. The third or downstream drainage system shall be laid to the lines and grade shown. The crushed stone for the drainage systems will be furnished by the City of Martinsville, Virginia, from its quarry at no cost to the Contractor except for loading transportation and placing of the material. The Contractor will receive the stone at the quarry and provide all necessary labor and transportation necessary for placing it in its final position in the drainage system as required by the plans and specifications. ~~The lower level drainage pipe shall consist of perforated asphalt coated corrugated galvanized iron drain pipe.~~ The upper level and downstream drainage systems may be of either extra strength terra cotta or concrete culvert pipe.

SURFACE DRAINAGE SYSTEM

The Contractor shall furnish and install all materials and labor necessary for the complete installation of the surface drainage system consisting of drainage ditches, sloped to catch basins or drop inlets and connecting piping as shown on the plans, cross sections, and profiles. The catch basins shall be of concrete construction using Class "A" concrete or best quality concrete block (not cinder block) sidewalls and concrete floors and cover slabs as shown on the plans. The drain pipes shall be concrete or terra cotta according to A. S. T. M. specifications. Joints shall be made with cement mortar and oakum. Backfilling around the pipe lines or catch basins shall be thoroughly compacted and conform to the compaction required for the various sections of the dam.

The drain lines shall be laid to straight grades between the manholes and catch basins or other structures or control points.

Drain lines from the underdrainage systems of the dam shall be connected into the surface drainage system at the points indicated on the plans. Drain lines from the pumping station will be connected into the surface drainage system as indicated on the plans and as covered under the specifications for the pumping station.

The drain line from the concrete conduit through the dam will be connected into the surface drainage system.

An underdrainage system shall be provided under the spillway and spillway canal as shown on the plans to prevent uplift from ground water on the floor slabs and side walls of the canal pavement, all as shown on the plans.

This canal drainage system shall consist of crushed stone and concrete or terra cotta pipe drain pipe run to the surface of the canal as indicated.

Crushed stone for the underdrainage system will be furnished by the City as described above.

CONCRETE

All concrete in connection with the intake tower, the pipe conduit through the dam or paving the spillway and canal shall be Class "A" concrete. Concrete for the anchor block for the cable connecting to the intake tower and located on the top runway of the dam shall be Class "B" concrete. Concrete for catch basins, drop inlets, head walls and other drainage structures and the conduit outlet manhole shall be Class "A" concrete.

INTAKE TOWER

The intake tower will consist of a reinforced concrete tower with a brick super-structure having a concrete slab roof. Concrete and excavation for the tower shall be as described elsewhere in these specifications. Openings shall be provided in the intake tower as indicated on the plans and the cast iron wall sleeves shall be installed and incorporated into the concrete work as the concrete is poured. The inlet elbow, the extension spool of cast iron, and the gate valve, and valve stem guides and floor stands shall be furnished and installed by the Contractor for Project No. 5.

The outlet pipe from the inside face of the intake tower downstream to the pumping station will be furnished and installed by the Contractor for the pumping station. These Contractors shall cooperate with each other in the installation of the pipe section which is to be placed in the concrete closure between the intake tower and the conduit. The gate valves shall be A.W.W.A. standard for 125 lbs. water working pressure and flanged pattern, bronze mounted, iron body, with inside screw and yoke and extension stems for operation by the floor stands, indicated on the plans. The floor stands shall be of the geared type with crank handles and placed so that any valve may be operated without interference with other valves or operators, or valve crank handles. The extension shafts and guides shall be furnished with the floor stands and valves.

The cast iron elbows for the valve inlets shall be Class "B" flanged type. The valve fittings and spools shall be flanged type Class "B". All cast iron fittings shall be painted with bituminous enamel.

Ladder rungs shall be provided as indicated on the plans both inside and outside of the tower in order that access may be obtained to the interior or exterior of the building at any elevation of the water in the lake. The intake tower will be accessible only by boat and the ladder available from the water level to the floor level of the super-structure or valve operating platform level.

The Contractor shall furnish and install the floor plates and frames for hatchways into the interior of the intake tower as indicated on the plans. These shall be 1/4 in. checker plate hinged covers with angle iron frames and painted with a bituminous enamel which will be hard and smooth when dry.

All ladder rungs and extension stems and guides shall be painted with a hard bituminous enamel of similar quality.

Steel or aluminum framed windows with double strength clear glass set in putty shall be furnished and installed as shown on the plans. A wood door and frame of the dimension shown and not less than 2-1/4 in. thick shall be furnished and installed as shown on the plans and the carpentry work and painting for windows and door shall be in accordance with the specifications for this type of work, as described for the raw water pumping station.

PAINTING

The woodwork and metal work shall be painted in accordance with the specifications for similar items under the raw water pumping station. Floor stands and handles shall be painted two coats of a red machinery enamel.

~~The windows and door shall be given a priming coat and two~~ finished coats of dark green outside gloss, best quality lead and oil deck paint.

PIPE RAILINGS

Furnish and install the 1-1/2 in. galvanized steel pipe rail around the platform of the balcony at the operating floor level as indicated on the plans. This railing shall be rigidly anchored to the building and platform as shown and shall be of welded or screwed construction. After installation it shall be given two coats of aluminum paint as described elsewhere in these specifications.

CONDUIT THROUGH THE DAM

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Concrete Conduit

The plans indicate a concrete conduit through the dam intended for conveying the flow of the stream during construction and after construction is complete this conduit will provide means for installing the raw water supply main connection between the intake tower and the raw water pumping station as described elsewhere in these specifications. The plans indicate the construction of a reinforced concrete slab over which is to be constructed an arched shaped tunnel sectioned to provide the finished conduit. Expansion joints, construction joints and water stop collars are required for this conduit and are indicated on the plans. A special seal is provided between the tunnel and intake tower as shown on the plans and is to be considered a part of the construction of the intake tower and no separate payment will be allowed for this item. Concrete work, reinforcement, reinforcing steel, and all other details of construction of the conduit shall be in accordance with the detailed specifications for concrete and concrete material. The concrete shall be Class "A" concrete.

Alternate Type Conduit Construction

Steel Plate Conduit - As an alternate to the concrete construction indicated on the plan a proposal is requested for an alternate type of construction consisting of a conduit 78 in. inside diameter constructed of corrugated curved sections of galvanized steel plate protected with a bituminous coating as hereinafter described. Where diaphragms or water stop collars are called for on the concrete conduit in the event that the steel plate conduit is supplied, then the Contractor shall construct the water stop rings of concrete around the steel plate conduit in the same manner as indicated for the concrete conduit and at the same interval.

The steel metal conduit if used shall be constructed on a thoroughly compacted sub-grade and the fill under and around the conduit shall be compacted with pneumatic hammers as described elsewhere in these specifications and particular attention shall be given to compacting the earth under and against the bottom of the conduit in order to prevent any possibility of seepage along this section of the conduit.

The metal plate type conduit shall consist of galvanized corrugated metal plates shaped to form a cylinder and provide a multi-centered segmental type structure of the length indicated on the plans when assembled in place, beginning at the intake structure and terminating in the outlet manhole of the conduit. The diameter of the pipe covered by these specifications is 78 in.

Plates shall consist of structural units of galvanized corrugated metal. The corrugation shall run at right angles to the longitudinal axis of the structure and shall have a pitch of 6 in. with a tolerance of 1/4 in. and a depth of 1-3/4 in. Single plates shall weigh not more than 700 lbs. The joints shall be capable of transmitting the design thrust and moment through the joint.

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. All parts of each plate shall be curved.

The plates shall be manufactured from base metal made by the open hearth process and shall conform in chemical properties to the requirements for the pure iron section of THE CHEMICAL COMPOSITION TABLE OF THE CURRENT A.A.S.H.O. SPECIFICATIONS K-36.

Spelter Coating

A coating of prime western spelter or equal shall be applied to the plates by the hot-dip process at the minimum rate of two (2) oz. per sq. ft. of double exposed surface.

If the average spelter coating as determined from the required samples is less than the amount specified or if any one specimen shows a deficiency of .20 (0.20) ounce where a two (2) ounce coating is specified or a deficiency of .30 (0.30) ounce where a three (3) ounce coating is specified, the lot sample shall be rejected. Spelter coating shall be of first class commercial quality free from injurious defects, such as blisters, flux, and uncoated spots.

Sampling

For testing weight and spelter coating and for commercial analysis of base metal when required, a sample of approximately three inches square or a sample of equivalent area shall be cut from one plate in each 100 plates of a shipment or fraction thereof.

Inspection

Inspections of the material shall be in accordance with A. A. S. H. O. Specifications K-36 and the specifications for SPALTER COATING shall be in accordance with current A.A.S.H.O. standard methods T-65 except as hereinafter modified.

Certified Analysis And Guarantee

The manufacturer of the base metal shall file with the Engineers a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of carbon, manganese, phosphorus, sulphur, silicon, and copper. The certificates shall be sworn to for the manufacturer by a person having legal authority to bind the company.

The manufacturer shall include in the certificate a guarantee providing that all metal furnished shall conform to requirements for that particular base metal, shall bear a suitable identification brand or mark and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge, or spelter coating, the cost to be limited to the replacement of structural plate material only, and the guarantee shall be so worded as to remain in effect for a period of one year after completion of the structure.

~~One brand and one brand only~~ shall be approved for each kind of base metal furnished by each of the actual manufacturers of the base metal.

Identification

Plates will not be accepted unless the metal is identified by a stamp on each plate showing:

1. Name of base metal manufacturer
2. Name of brand and kind of base metal
3. Gauge number
4. Weight of spelter coating
5. Identification symbols showing (heat number)
(pot number)

~~The identification brands shall be so placed that when the~~
pipe is erected the identification will appear on the inside of the structure.

Gauge Determination and Tolerance

The gauge of plates shall be determined by weight of flat plates before corrugating. Theoretical weights and tolerances shall be as follows, based on U. S. Standard Gauge Measure:

Gauge	Theoretical Wt. Before Galvanizing (Lbs. per Sq. Ft.)	Theoretical Wt. After Galvanizing (Lbs. per Sq. Ft.)	Permissible Variation in ave. wt. of lots (in percent)	
			Over	Under
3	10.00	10.156	4	3

Field Inspection and Acceptance of Plates

The field inspection shall be made by the Engineers, who shall be furnished with an itemized statement by the manufacturer of the number and size of the plates in each shipment.

Each plate included in a shipment shall fully meet the requirements of these specifications and paragraph 23 of A.A.S.H.O. Specifications 11-33; and if twenty-five (25) percent of the plates in any shipment fail to meet the requirements, the entire shipment may be rejected. Any plate failing to meet the specification requirements or on which the splinter has been bruised or broken or which shows defective workmanship, will be rejected.

Bolts

The bolts and nuts for connecting plates shall be not less than three-fourths ($3/4$) inch in diameter and shall be hot-dip galvanized. The threads shall be American National Coarse Thread Series, Class 2 fit. The bolts shall be of sufficient length to extend through the nut.

Bolt heads and nuts shall be designed to provide even and uniform bearing on the bolted surfaces of the plates.

The finished bolts shall meet the following physical test requirements:

Minimum tensile strength	110,000# per sq. in.
Minimum shear	80,000# per sq. in.
Minimum reduction of area.	35 percent
Brinell hardness between the limits. . .	241-286

Fabrication

(a) Forming and Punching Plates - Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the drawings or specified. The bolt holes shall be so punched that all plates, having like dimensions and curvature, shall be inter-changeable.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows two (2) inches apart, with one (1) row in the valley and one (1) in the crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than twelve (12) inches. The minimum distance from center of holes to the edge of the plate shall be one and three-fourths ($1-3/4$) times the diameter of the bolt. The diameter of the bolt holes in longitudinal seams shall not exceed the diameter of the bolt by more than one-eighth ($1/8$) inch.

Design

Physical Properties of Corrugated Structural Plates - Each manufacturer of corrugated structural plates shall furnish data sheets showing the physical properties of the gauge of plates and the joint design to be supplied under this specification.

The thickness of all plates shall be sufficient to withstand an outside crushing load from the compacted fill of the dam of 8,000 pounds per sq. ft. of exterior surface of the conduit.

Bituminous Protection

After the plates have been fabricated and galvanized, they shall be given a snap application of bituminous material in accordance with Public Roads Administration Specification FP-41, Item 255. Any surfaces damaged before completion and acceptance of the conduit shall be re-finished without cost and placed in first-class condition. A coat of bituminous protection shall be applied to the surfaces in contact with each other before assembly. All bolts shall be carefully coated with the bituminous coating material after assembly.

CONDUIT OUTLET MANHOLE

The contractor for Project No. 5 shall construct the outlet manhole for the conduit as shown on the plans providing the brick partitions as indicated.

PIPE THROUGH THE DAM

The cast iron pipe through the dam will be furnished and installed under the contract for the raw water pumping station.

PREPARATION OF SPILLWAY

If solid rock excavation is encountered in sufficient quantity and area in any part of the spillway, the rock will be excavated to the finished surface of the spillway to within plus or minus 0.25 of a foot of the elevation shown on the plans and no concrete pavement will be required for such areas. Test excavations have not indicated any rock in sufficient quantity or strength to justify its use as a foundation material or as a surface for the spillway or canal.

SPILLWAY AND SPILLWAY CANAL

Excavation for the spillway and canal will be as described above and the entire areas of the floor of the spillway and canal and sidewalls shall be paved with Class "A" concrete to the limits shown on the plans and in accordance with the details thereof.

Expansion joints shall be provided in the concrete pavement and walls as indicated on the plans, which will consist of joints containing expansion felt of asphalt and the joints shall be equipped with dowels, one end of which will be anchored in the concrete slab and the other shall be coated with asphalt or wrapped with asphalt paper in order to provide horizontal movement of the slab without distortion of the general surface of the exposed concrete at the joint.

PREPARATION OF FOUNDATION

The entire foundation for the dam shall be thoroughly cleaned and all loose rock, earth, organic matter, debris, and foreign matter shall be removed from the entire foundation before any compacted fill is placed thereon, or any concrete is poured in connection with the spillway section canal, or the intake tower.

Excavation for the pipe conduit under the dam shall be to the lines and grades given on the plans and if concrete collars are used, the concrete shall be poured on a thoroughly compacted and stable foundation either of rock or earth, as the case may be, to obtain the lines and grades given. Any earth backfill under the conduit shall be compacted as hereinafter required for compacted earth fills.

PREPARATION OF FOUNDATION UNDER CLASS "C" BALLAST

Where Class "C" ballast rests on original ground, the original ground shall be scarified to a depth of not less than 8 in. with rippers pulled by crawler type tractor.

The Contractor shall then compact the subgrade to support the Class "C" ballast at optimum moisture content to a density of not less than 96% as compared to the density of the same material when tested in accordance with the AASHTO-99, using sheep foot rollers applying a pressure of not less than 600 lbs. per sq. in. or other type of approved compacting equipment which will provide the same equivalent loading.

If, for any reason, the base or foundation under the Class "C" material is not immediately covered by the Class "C" ballast, and the foundation has become cut or rough it shall be rerolled in accordance with the above requirements unless soft spots or mud holes have developed, in which case this soft material shall be either removed or covered with a dry material which shall be rolled into the soft material until it has compacted in accordance with the above requirements.

In all places inaccessible to the rolling compacting equipment and especially against the sides of the conduit through the dam, power driven compacting equipment consisting of pneumatic tampers or similar approved equipment shall be used to obtain the necessary compaction both against the foundation and against the surfaces of the conduit. Pneumatic tamping equipment shall be used for compacting the fill over top of the conduit for a depth of at least 12 in. or until the rolling compacting equipment can be safely moved over the conduit without damaging or displacing same.

If sandy material, loam, or other unstable soil or porous material is encountered under any section of the dam, the same shall be removed and replaced with suitable material approved by the Engineers. Any replacement material shall be compacted in accordance with the above requirements.

CLASSIFICATION OF MATERIAL

The material to be incorporated into the embankment for the dam shall be as follows:

Class "A" Clay Core

This material entitled Class "A" clay core shall be used for constructing the impervious compacted clay core of the best quality of material available to provide a watertight cutoff core to prevent water passing through the dam. This material will consist of the most suitable clay encountered in the borrow pit and to be obtained from an area indicated on the plans as general borrow pit area. This material occurs for the most part below the level of the top soil for a depth of several feet in a general northwest direction from the dam. If sufficient Class "A" material is encountered, it may be used in all other sections of the dam, but sufficient Class "A" clay core material must be assured before it is used in sections other than indicated. This material is easily workable, red in color, and relatively free of grit or sand, and will probably occur in such condition that its moisture content is approximately the optimum moisture content for maximum compaction if used directly from its original location in the borrow pit.

Class "B" Ballast

Class "B" ballast will consist of the second grade clay material available from the same borrow pits as described for the Class "A" clay core material, and will probably occur both above and below the Class "A" material in its original location. If surplus Class "A" or Class "B" materials are encountered, they may be used in lieu of the Class "C" ballast, but it must be determined that sufficient Class "A" and Class "B" material are available for the use called for before it is used in place of the Class "C" material.

The Class "B" ballast will consist of clay which may not be equally plastic or workable as compared to the Class "A" material, and may contain a small percentage more of grit or sand than the Class "A" material, but in no case is sandy, loam, or disintegrated rock or similar loose porous material to be incorporated in the Class "B" ballast.

Class "C" Ballast

The Class "C" ballast will consist of any surplus Class "A" or Class "B" material and if sufficient quantities are not available then the Class "C" material may consist of selected original deposits of sand clay material or clays whose plasticity and workability are inferior to the Class "A" or the Class "B" material.

The exposed surfaces of the Class "C" ballast sections may consist of a layer of approximately 36 in. of sandy loam or top soil material free from excessive or bulky organic matter. Since this exposed area is to be seeded and planted in grass or suitable cover crops for protection against erosion and deterioration of the exposed surface.

BORROW PITS

~~Borrow pits shall be cut to suitable grades in order to obtain~~ the material in a convenient manner and select the quality of the material as necessary for the construction and provide for the removal of the stratified deposits of clay of various types necessary for the various sections of the dam. Borrow pits will be confined to areas approved or recommended by the Engineers. The most suitable area is indicated by the plans and entitled General Borrow Pit Area.

All vegetation such as trees, heavy growths of grass, weeds, underbrush, heavy sod, decayed organic matter, rubbish and any other unsuitable material occurring in the areas from which borrow material is to be taken shall be scalped or otherwise removed before the excavation for the embankment material is started, and in no case shall such objectionable material be allowed or incorporated in or under the embankment of the dam. The borrow pits shall be cleared in accordance with the specifications for clearing before the initial ~~cross sections are taken for the borrow pit area.~~ The Contractor shall perform the work required under these sections and shall notify the Engineers sufficiently in advance of the opening of any borrow pit so that cross-sectional elevations and measurements of the undisturbed surfaces of acceptable materials may be taken. The Contractor shall provide the necessary assistance, materials and common labor for assisting the Engineers' representatives in taking these cross section elevations as called for under appropriate headings of these specifications and for opening test holes for exploring the extent of the borrow pit areas before borrowing begins. Cross sections have been taken over the entire area of the dam and spillway sections and some of the area from which borrow material is to be taken, but it is probable that this area will be extended and the above conditions shall apply.

The waste material from the borrow pit consisting of the top soil, sod, or other unstable material shall be moved out of the way of the excavation operations and deposited in a manner satisfactory to the Engineers. After the material is moved, this material may be redistributed over the excavated areas in a satisfactory manner approved by the Engineers in order that the minimum movement of material may be obtained. After the completion of the excavation, the borrow pit shall be left in such manner that depressions or low places in which water may collect are eliminated and satisfactory drainage provided for

the entire area. The slopes shall be left in a neat and satisfactory manner in order to prevent erosion. Material which can be burned such as trees or stumps shall be piled and burned at convenient points.

Satisfactory material of proper classification taken from the excavation for the foundation of the dam may be used in the Class "C" ballast section if same conforms to the requirements for Class "C" Ballast. The materials taken from the excavations for the spillway and canal may be used in the various sections of the dam where it conforms to the respective requirements for the material classification for which it is intended to be incorporated into the dam.

PLACING EMBANKMENTS

After the foundation has been prepared as described above, compacted earth fills shall be placed on all sections of the embankment of the dam.

Any embankments of the dam, regardless of type, that is Class "A" clay core, Class "B" ballast, or Class "C" ballast, shall be placed in layers not to exceed 6 in. in loose depth and rolled with a sheep foot type of roller or approved equipment providing a compacting pressure of not less than 600 lbs. per sq. in. The material shall be spread in a continuous layer over the entire surface of the respective classes of embankments before the succeeding layers are brought up in order that the maximum compaction may be obtained. This material shall be compacted at optimum moisture content to a density of not less than 90% as compared to the density of the same material when tested in accordance with AASHTO-99 using power rollers. In any case, the material shall be compacted by sufficient passes of the rolling equipment until it is not cut or displaced by the movement of the equipment. In placing the embankments the Contractor shall so far as practicable slope the surfaces to the sides in order that water may not be impounded on the surface of the unfinished sections and cause ruts or soft spots and if same occur, he shall remove such soft material or stabilize such soft material with stable material as called for above. At all times the Contractor shall exercise care in preventing unsuitable material from being deposited or incorporated in the construction of the embankments as vehicles transport material across the construction. No rock over 6 inches in diameter shall be incorporated in the embankment except in the Class "C" Ballast in which stones not larger than 12 inches in diameter may be used.

All embankments shall be formed of earth or material approved by the Engineers. Sod and vegetation shall not be used in making embankments. The material for the embankments is classified under three different types as hereinbefore described.

COMPACTION OF EARTH FILL EMBANKMENTS

The per cent of compaction in the field will be determined by the following procedure:

Approximately 15 lbs. of material will be taken with a post hole auger and weighed. The moisture content will be determined without loss of time so that the sample will not lose moisture by drying.

The hole will then be filled with dry sand of known loose weight per cu. ft. and the volume of the hole computed. The dry weight per cu. ft. and the per cent compaction will be determined as follows:

Dry weight per cubic foot equals

$$\frac{\text{Net weight per cu. ft.} \times 100}{100 + \text{moisture content}}$$

Percent compaction equals

$$\frac{\text{Dry weight per cu. ft.} \times 100}{\text{Maximum dry weight per cu. ft. from laboratory curve}}$$

The exposed surfaces of compacted earth filled embankment shall conform to dimension shown on the plans and shall be crowned or sloped as indicated. During construction the embankment shall be sloped or graded sufficiently to throw the rainfall and runoff to the outside of the dam in order to prevent the formation of soft spots or mud puddles within the embankment surfaces.

The Contractor shall use reasonable care to minimize tracking and rutting and shall fill and reroll all tracks and ruts.

Earth for embankments and fills shall be placed at approximately optimum moisture content. Material which does not contain sufficient moisture to compact in accordance with the specified requirements shall be sprinkled with water as directed by the Engineers. Materials containing excess moisture shall be permitted to dry to the proper consistency before being compacted. A water sprinkling wagon or pump and hose lines shall be available at all times to provide the necessary moisture when required.

The cost of handling, transporting, placing, compacting, and all other work of forming embankments as specified shall be included in the unit price named in the proposal for regular excavation.

MEASUREMENTS AND PAYMENTS

Method of Measurement

The yardage for excavation to be paid for shall be the yardage measured in the original position by the method of average end areas of material acceptably excavated as herein above described and as determined by final cross section upon completion and acceptance of the work. Measurement of the cross sections will be by means of planimeters from the plotted cross sections.

Basis of Payment

The yardage of excavation measured as above provided shall be paid for at the contract unit price per cu. yd. bid for this work, which price and payment shall constitute compensation for stripping, grubbing, removal of top soil, excavating, hauling first 1500 ft. (and except overhaul), formation and compaction of embankment, compaction of sub-grades in cuts, preparation of subgrades, finishing embankments, slopes, ditches, excavation of borrow pits and channels, disposal of surplus material and furnishing of all labor, equipment, tools, and incidentals necessary to complete the above work in accordance with the plans and specifications, not covered by other unit prices.

Replacement of top soil except on surfaces of the dam shall be paid for at the unit price allowed for grading, excavation, and compaction when so ordered by the Engineers.

Overhaul shall be allowed for each one-half mile increment beyond the first 1500 ft. Payment shall not be made for haul less than 1500 feet. The distance to be allowed for overhaul shall be measured from the approximate center of embankment made by the overhaul to the approximate center of the borrow pit from which such overhaul is made. Payment shall be made on a cubic yard basis per unit overhaul distance measured according to the paragraph entitled "Method of Measurement". No overhaul will be allowed for any material taken from any part of the boundary marked clearing for dam contract.

Payment for rehandling of top soil shall be made at the unit price for excavation where same is authorized, but top soil used in the exposed surfaces of the dam as described above for the Class "C" ballast area will not be paid for except as excavation used in the embankment, as this top soil if used shall be placed as it is encountered in the excavation and in accordance with the progress of the completed and compacted embankment. No rehandling of this top soil is expected and will not be paid for as rehandled material. Measurement for payment for rehandling shall be made of the top soil stock piles as placed by the Contractor and quantity shall be computed by the method as set forth above.

Water necessary for providing moisture for the embankment may be obtained from the stream at the job site and applied to the surfaces to be treated with the water by suitable means. No additional payment shall be provided for sprinkling or watering the surfaces in order to obtain the optimum moisture content.

RIP-RAP

Where rip-rap is shown in connection with the upstream face of the dam or other areas, it shall consist of hard rock in sizes larger than 4 inches. The stone will be furnished free of charge at the quarry operated by the City of Martinsville. The Contractor shall

provide handling and transporting at his own expense. The upper and lower lines of the edge of the rip-rapped area of the upstream face of the dam shall be reasonably true to line. The stone may be dumped from the truck directly on the face of the dam and may be hand placed in a protective mat to within plus or minus two inches of the 12 inch depth called for. An alternate which the Contractor may elect if he so desires consists of placing the rip-rap as it is dumped from the vehicles in a layer of more irregular depth wherein the depth of the stone must be within plus or minus 3 inches of 12 inch average depth in lieu of the 12 inch hand placed stone. In either method of placing, the Contractor shall take care to provide a thoroughly covered area free of conspicuous voids.

Rip-rap will be paid for on the basis of the square yards accepted by the Engineers based on horizontal measurements.

CARETAKERS COTTAGE FOR CONTRACTORS FIELD OFFICE

The Contractor for the dam as covered by Project No. 5 shall provide at the dam site a temporary field office for the Engineers having a floor area of 12 by 15 ft. in which plans, instruments, samples, specimens, and records may be stored during construction. This space will also serve as the testing laboratory for the earth of the embankment for the dam. Heat consisting of a wood burning stove shall be provided for the temporary office. The office shall have a floor of wood or other acceptable material. It shall also have a work table or plan shelf 4 ft. by 5 ft. in area, together with one window and one door.

The Contractor for Project No. 5 shall also provide one sanitary privy meeting the requirements of the Virginia State Department of Health for use of the Engineers' Inspector, and located below the dam at a point approved by the Engineers.

The Contractor for Project No. 5 is also required to submit a proposal for a caretaker's cottage as shown by scheme A of the accompanying plans. This caretaker's cottage will serve in lieu of the above temporary field office and privy and the additional space would be available for the use of the Contractor in place of his temporary field office and store house at the dam. The Contractor's proposal is to be based on the additional cost of the Scheme A caretakers cottage over the cost of the temporary field office and privy for the Engineers use and the contractor's temporary office and store house.

The caretaker's cottage hereinafter called the cottage shall be constructed of cinder block on concrete foundations. The concrete shall be Class "A". The floor shall be Class "A" concrete and smooth finished and dense. Concrete work shall be in accordance with the

requirements for "concrete" contained elsewhere in these specifications.

Cinder blocks and lintels and construction shall conform to the requirements for this class of work as described elsewhere in these specifications.

The roof shall consist of timber trusses of S. P. I. B. Class "B" or better dry lumber, wood sheathing and asphalt mineral surfaced shingles.

The ceiling shall be composed of 1/2" plywood or 3/4" celotex or white finished plaster board at least 1/2 inch thick.

Windows shall be steel casement type, with single strength clear glass set in putty.

Doors and frames shall be of wood and of the size and type shown on the plans. Doors and windows shall be fitted with approved handles, knobs, and locking devices. Outside doors shall have cylinder locks.

All the carpentry work for doors shall conform to the specifications for this type of work described under the Raw Water Pumping Station specifications.

All exposed woodwork and metal shall be painted as described under "Painting" of the Raw Water Pumping Station specifications.

The cottage shall include completely installed one lavatory Standard Sanitary Company No. P 4338 EZ "Beverly" or equal, equipped with compression faucets, rubber drain plug and trap, and one water closet Standard Sanitary Company P 2469V3 "Modernus" or equal, with cast iron enameled closet tank P 6400 and valves and fittings and white "church" seat and cover. Water piping shall be galvanized iron and the drain line from the above fittings, a future shower bath, and kitchen sink shall be connected to the septic tank covered by the Raw Water Pumping Station contract. The Contractor for the cottage shall also rough in for the supply and drainage fittings for the shower bath and kitchen sink, leaving the connections plugged at the floor or wall line. Plumbing shall be in accordance with standard practice and as approved by the Engineers. The water supply shall be brought by the Contractor, for the cottage, from the raw water pumping station domestic supply filtered water system. This supply line shall be 3/4 inch galvanized steel pipe run 18" underground.

The electric work shall be done as shown on the plans and in accordance with the National Electric Code. The wiring shall be run in rigid galvanized metallic conduit. Galvanized iron gutters and down spouts shall be furnished as shown.

No interior plastering is required except bath room which shall be plastered with Keene cement smooth finished plaster. Cinder block walls will not be painted.

Upon completion of the entire project, the Contractor shall thoroughly clean up the cottage and premises.

SEEDING AND PLANTING

Soil Preparation and Seeding

Grading and embankment work shall be completed before seeding operations are commenced. These operations consisting of grading and embankments which shall leave the surface finished to within plus or minus .2 of a ft. of the surface indicated by the plans and shall be left in a neat and uniform appearance before the seeding operations are commenced.

Soil preparation and seeding and related items necessary to complete the work shown or specified are a part of this contract and soil preparation and seeding and related items will be paid for at the contract unit price named in the proposal.

See "Excavation" which includes grading and other operations to be completed before work of soil preparation and seeding can proceed.

The top soil shall be reasonably cleaned of plants, roots, stones, and other extraneous matter. Top soil shall be spread on the site or removed as directed. The areas to be prepared and seeded shall include all exposed surfaces of the dam except that covered by rip-rap and below the elevation 828 on the upstream surface of the dam. It shall also include all areas between the dam and the canal and the surfaces adjacent to the canal which are disturbed by clearing or grading in connection with the construction of the canal, also the areas adjacent to the wings of the dam and around the raw water pumping station and not covered by the building or by the cottage, roads, walks, or other surfaced areas.

All areas shall be treated at the rate of 20 lbs. to 1,000 sq. ft. of surface with a commercial fertilizer. Such fertilizer shall be composed by weight of five per cent nitrogen, ten per cent of phosphoric acid, and five per cent of potash. Twenty per cent of the total nitrogen must be derived from organic material. The fertilizer shall be the product of a reputable manufacturer and tags must be furnished showing the manufacturer's guaranteed analysis.

The fertilizer shall be applied at least ten (10) days before the lawn is planted and raked into the top 2 inches of the surface.

The areas shall be seeded at a rate of 5 lbs. per 1,000 sq. ft. of lawn area with a lawn mixture composed by weight of 50% *Poa pratensis* (Kentucky Blue Grass), 45% Perennial Rye (*Lolium perenne*), and 5% Dutch White Clover. The seed shall be fresh and clean, and may be mixed by approved method on the site or by the dealer. The Contractor shall furnish the dealer's guaranteed statement of percentage of purity and germination of each variety, and if mixed by the dealer shall furnish statement of the composition of the mixture. ~~The lawn seed shall conform to the following minimum percentages of~~ purity and germination.

<u>Name</u>	<u>Purity Per Cent</u>	<u>Germination Per Cent</u>
Blue Grass	80%	80%
Perennial Rye	90%	90%
Dutch White Clover	90%	90%

The seed shall be sown evenly and lightly raked into the ground after which the ground shall be compacted and thoroughly wetted with a fine spray.

Where there is danger of erosion or it is otherwise difficult to secure a satisfactory lawn, the area may be seeded with a good quality of lawn grass reasonably free from weeds, and meeting the approval of the Engineers.

The planting shall be done during the season or seasons which are normal for such work as determined by weather conditions and by accepted practice in locality of project. At option of and on responsibility of Contractor, planting of lawns may be done under unreasonable conditions without additional compensation.

Commence work at the earliest practicable date regardless of time of year. As soon as other divisions of the work have progressed sufficiently commence work of seeding.

The grass shall be planted after loosening the soil to a depth of not less than eight inches. Remove stones over 2 in. in any dimension, sticks, rubbish and any other extraneous material and grade to remove ridges and depressions.

The fertiliser shall be applied at the rate specified above and work into the soil at least ten days before planting.

The ground shall be scarified as necessary and raked until surface is smooth, friable and of uniformly fine texture immediately before planting grass.

The seed shall be sown as specified at the rate indicated; rake lightly, roll with 200 lb. roller and water with a fine spray.

The establishing of grass on slopes or banks shall be the responsibility of the Contractor. Special care shall be exercised to prevent erosion.

The seeded areas shall be maintained, begin immediately after ~~each portion of area is planted and shall continue in accordance with~~ the following requirements:

The areas shall be maintained for at least 45 days, and as much longer as necessary to establish over the entire areas a close stand of grass.

This will include watering, weeding, replanting, rolling, mowing, trimming, and other operations necessary.

The areas shall be protected against damage including erosion; provide proper safeguards and protection to areas; replant damaged areas promptly.

The final inspection of the work of seeding will be made at conclusion of maintenance; written notice requesting inspection should be submitted at least 10 days prior to anticipated.

CLEANING UP ON COMPLETION OF THE WORK

After completion of the work the Contractor shall clean up the entire area occupied by his operations and shall pile or dispose of all debris and surplus materials in a neat and workmanlike manner in areas directed by the Engineers or shall burn trees or other combustible materials at convenient points and dispose of the ashes and remainder of the materials from burning. All areas shall be left graded so that drainage may be accomplished to prevent accumulation of water.

GUARANTEE

The Contractor is to deliver the work covered by these plans and specifications to the Owner, complete and in first-class condition in every respect, and to guarantee the material and workmanship for a period of twelve months from the time installation is completed. If during this time, any defects should show up due to defective material, negligence or want of proper care on the part of the Contractor, the latter shall furnish such new materials as are necessary, and repair said defects and put the work in proper order at his own expense on receipt of notice of such defects from the Engineers or Owner.

APPENDIX V

REFERENCES

APPENDIX V

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Washington, D.C., Department of Army, Office of the Chief of Engineers.
2. HEC-1, Flood Hydrograph Package, Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973.
3. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, U.S. Weather Bureau, April 1956.
4. "Rainfall Frequency Atlas of the United States," Technical Paper 40, U.S. Weather Bureau, May 1961.
5. Design of Small Dams, U.S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973.
6. "Geology of the Snow Creek, Martinsville East, Price, and Spray Quadrangles Virginia," Report of Investigations 33, Virginia Division of Mineral Resources, 1973.
7. "Geology of the Martinsville West Quadrangle, Virginia," Report of Investigations 16, Virginia Division of Mineral Resources, 1968.

APPENDIX VI

CONDITIONS

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CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data and a hydrologic analysis performed during a Phase I Investigation as set forth in the U.S. Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review, and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review, and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.